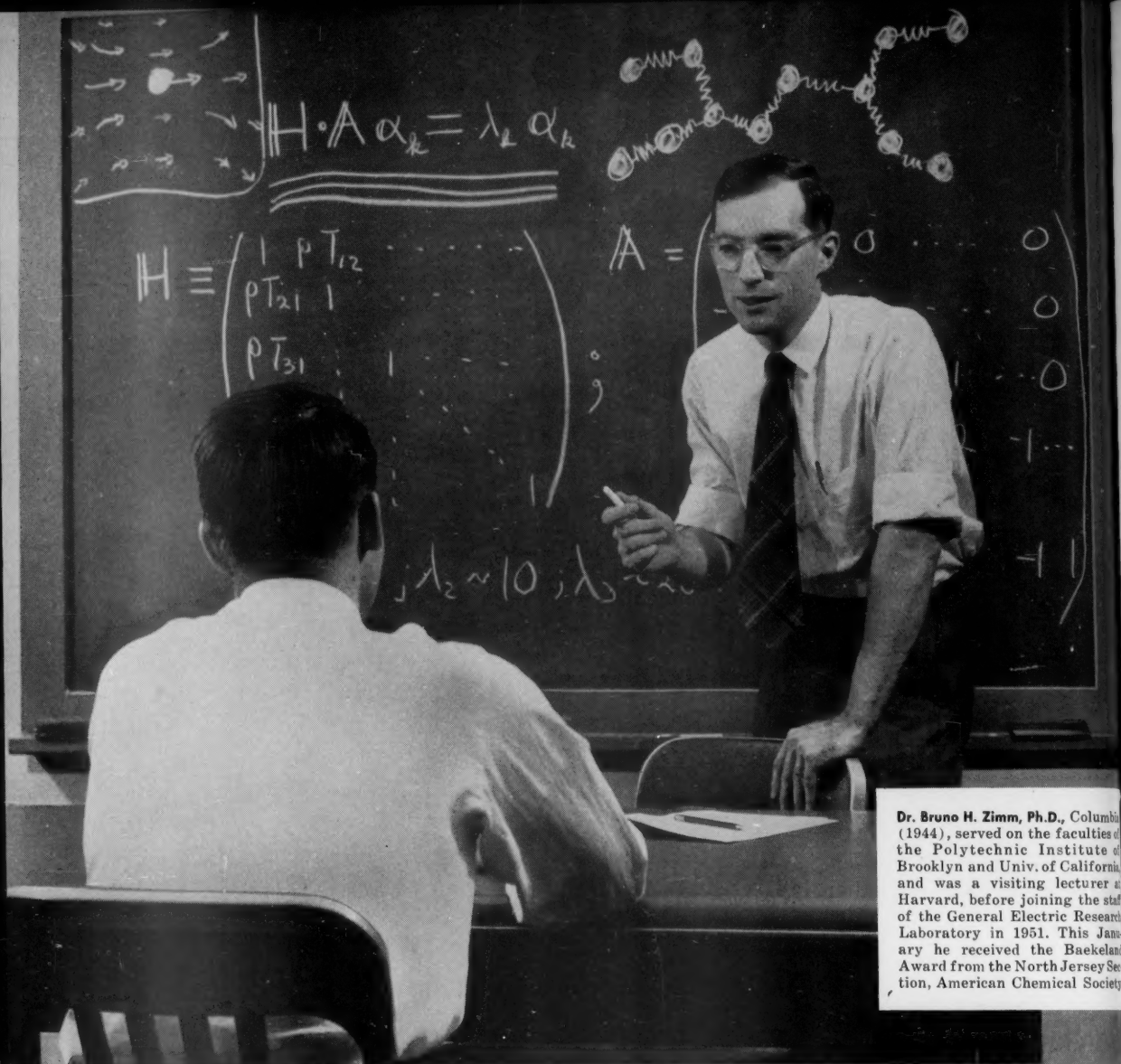


# SCIENCE

8 February 1957

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**Dr. Bruno H. Zimm, Ph.D.**, Columbia (1944), served on the faculties of the Polytechnic Institute of Brooklyn and Univ. of California, and was a visiting lecturer at Harvard, before joining the staff of the General Electric Research Laboratory in 1951. This January he received the Baekeland Award from the North Jersey Section, American Chemical Society.

## Learning more about molecules

**General Electric's Dr. Bruno H. Zimm attacks the problems of polymer chemistry both as theoretician and experimentalist**

The *weight* of molecules is more easily determined than their *size* and *shape*, but an understanding of these latter properties is equally essential in the designing of plastic materials.

At the General Electric Research Laboratory, Dr. Bruno H. Zimm and his associates are using the most recent techniques for studying molecules by projecting light beams through polymer solutions. How the light is scattered, its intensity at various angles, and similar observations have been related to the shape and dynamic properties of polymer molecules and thus to the eventual characteristics of plastic materials: strength, insulating properties, and flexibility.

For such experimental work, and for theoretical contributions to the understanding of how polymer chain molecules react when stress is applied, Dr. Zimm recently received the Baekeland Award of the American Chemical Society.

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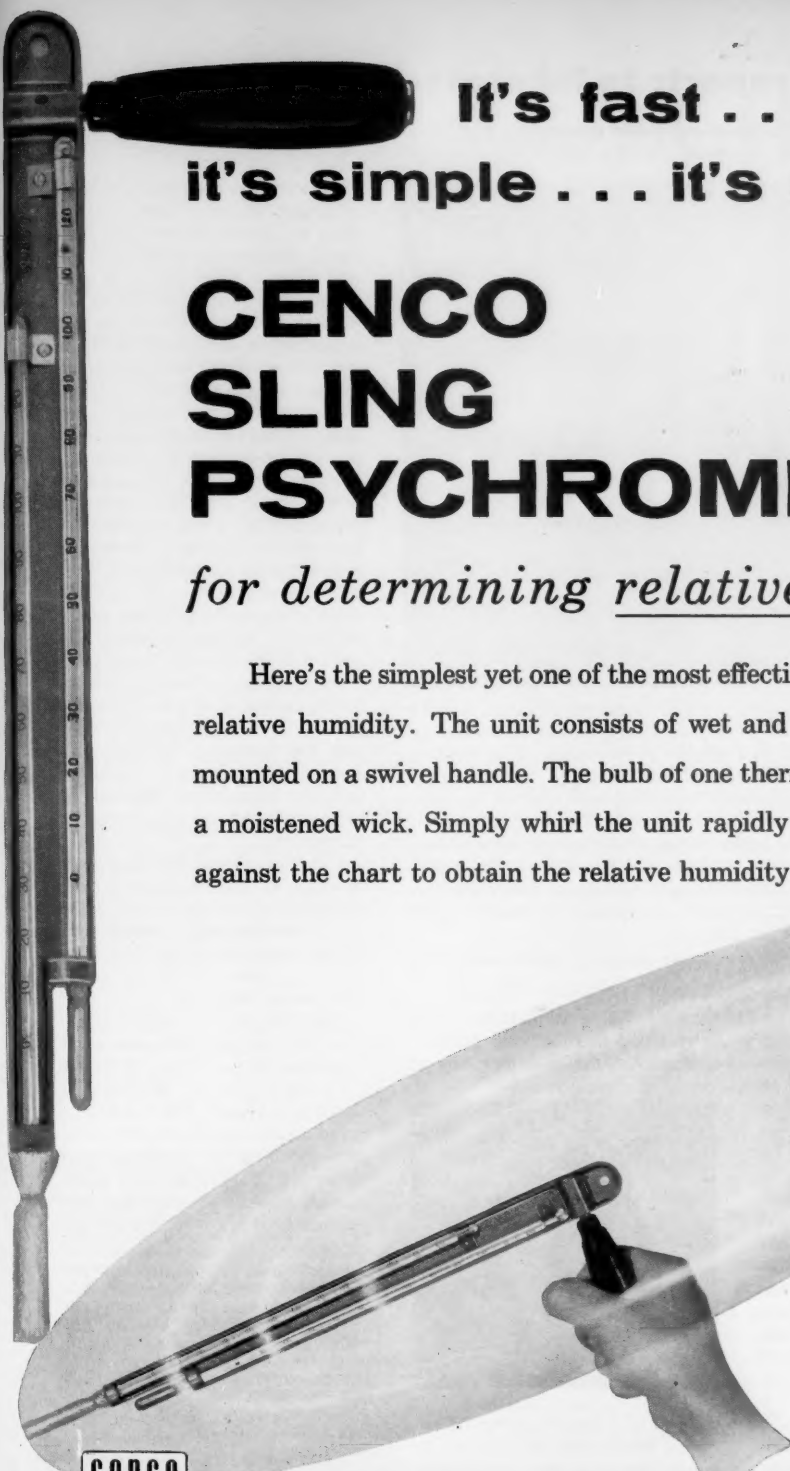
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SCIENCE is published weekly by the AAAS, 1515 Massachusetts Ave., NW, Washington 5, D.C. Entered at the Lancaster, Pa., Post Office as second class matter under the act of 3 March 1879. Annual subscriptions: \$7.50; foreign postage, \$1; Canadian postage, 50¢.

## Kodak reports to laboratories on:

our activity in infrared-activated devices... a pH indicator from Alleppey



The tallish building is our headquarters. From a laboratory of ours, a bread-boarded infrared scanning device we are working on looks across the city and picks out in broad daylight, in a window of the distant office building, a 480-cycle infrared flicker from a lamp filament scarcely warm enough to glow visibly. We choose this odd tidbit of technology as a means of announcing dramatically our desire to enter into conversations looking to research, engineering, and manufacturing undertakings which involve infrared-activated devices. We are rich in talent, facilities, and downright actual experience for work in all infrared domains: the photographic and metascope region to 12,000Å, the lead sulfide region to 3μ, the selenide-telluride region to 6μ, and the bolometer region to 15μ.

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### A bright, cheerful yellow

About 150 miles up the west coast from Cape Comorin, the tip of India, there stands the town of Alleppey. The farmers around Alleppey raise black peppercorns for the world's pepper shakers. As a sideline they also raise a little ginger, and each year they also set out rhizomes (underground root-like stems) of a plant known to botanists as *Curcuma longa*. From the upper side of the rhizomes leafy shoots develop, and from the lower side, roots. At harvest time the farmers dig up the new crop of rhizomes. These are then dried and milled to a yellow flour called turmeric, which is used to color the curries of India. Back in the old days a lot of turmeric

went into leather staining, but chemistry killed that off long ago.

Some of the rhizomes do get



shipped to a factory in Rochester, N. Y., which turns out mustard to put on hot dogs and hamburgers.

Americans like their mustard to be a bright, cheerful yellow rather than its greyish-brown self. Turmeric imparts the preferred color and adds a little flavor as well.

From the mustard people we buy modest amounts of turmeric and percolate hot acetone through it. In this simple manner we obtain sharp melting crystals of *Curcumin* (Eastman 1179), which is nothing more than 1,7-bis(4-hydroxy-3-methoxyphenol)-1,6-heptadiene-3,5-dione.

From an acidified solution containing boric acid and *Curcumin* one can obtain a red, alcohol-soluble reaction product, formed in proportion to the amount of boric acid present. There is a Ph.D. thesis in the archives of one of the midwestern universities which suggests that this red substance represents a loose combination of the borate radical with one of the two hydroxyls in *Curcumin*. At any rate, this reaction is the basis of a method for measuring boron in soils and plant tissue. We shall be pleased to send you an abstract of the method.

The big thing about *Curcumin*, however, is that it changes from yellow to red over the pH range 7.5 to 8.5 and from red to orange over the pH range of 10.2 to 11.8. This gives it a place on the list of 52 *Eastman pH Indicators*.

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SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at Business Press, Lancaster, Pa. Entered at the Lancaster, Pa., Post Office as second class matter under the Act of 3 March 1879.

SCIENCE is indexed in the *Reader's Guide to Periodical Literature* and in the *Industrial Arts Index*.

Editorial and personnel-placement correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D.C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. For detailed suggestions on the preparation of manuscripts, book reviews, and illustrations, see *Science* 125, 16 (4 Jan. 1957).

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## First Scientific Bureau

The Coast and Geodetic Survey celebrates its 150th birthday this week. It was established on 10 February 1807 when Congress authorized President Jefferson to begin a survey of the islands, shoals, and places of anchorage along the coast, so that ships carrying the nation's trade could navigate safely in time of peace and so that the nation would be protected against invasion in the event of war—this shortly before 1812.

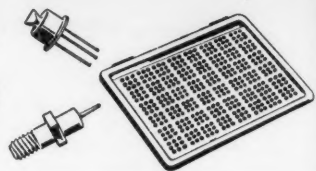
Today no one doubts that accurate nautical charts require careful scientific work and that scientific work costs money. However, the first superintendent of the survey, a geodesist born and trained in Switzerland, faced a less enlightened public. Ferdinand Rodolph Hassler's career is the history of a running battle between a Congress that did not understand the special demands of good research and a first-rate scientist who was able to impress other scientists but unable to talk to the layman.

Hassler wanted, first, to fix by astronomical observations the position of certain key points near the coast and, second, to establish a network of triangulations between these points, and only then to get down to the business of tracing the shoreline and sounding the coastal waters. Congress wanted immediate, palpable results and small appropriations. At one point, having run out of funds in an expedition to Europe to buy a theodolite and other equipment, Hassler returned only to have Congress take the work from him and place it in less capable hands. Fortunately, misunderstandings eventually were resolved, and Hassler's viewpoint prevailed.

Originally the survey was quartered in the Treasury Department, with brief service on two occasions in the Navy; in 1903 it became a bureau in the Department of Commerce and Labor, remaining in the Department of Commerce when the Department of Labor became a separate department. In addition to furnishing mariners with nautical charts, the survey provides fishermen with tide tables, fliers with aeronautical charts, and surveyors with starting points. Charting activities now include the Arctic coast of Alaska, the Bering Sea, and our coastal waters to the edge of the continental shelf. Other scientific investigations of the survey bear on marine currents, compass variations, earthquakes, and magnetic disturbances that affect radio communication.

The Coast and Geodetic Survey has become so much a part of our working government that a sesquicentennial celebration is necessary to bring it to our attention. However, some of the difficulties originally faced by the survey are still with us but in another context and on a much vaster scale. In an atomic age, when pure research can bear directly on the general welfare and common security, we again must ask how a political body is to decide upon appropriations for scientific work and how scientists are to make known their needs. We hope that today's problem of communication will be solved as successfully as it was for the first scientific bureau.—J. T.

New technique shapes future of transistors...  
**LEADS TO THREE MAJOR INVENTIONS**



Calvin S. Fuller, Ph.D. in Physical Chemistry from the University of Chicago, is a pioneer in development of the diffusion technique. Here he controls

a heating current through a strip of silicon while diffusing into its surface a film of aluminum less than 1/50th of a hair's breadth in thickness.

Transistor makers have a very difficult problem. They must add a mere trace of an "impurity" to a semiconducting metal. But they must add it only in very thin layers, without affecting the bulk of the material.

Bell Laboratories scientists developed an efficient new way to produce such layers. They expose the metal to a hot gas containing the impurity. Atoms bombard the surface and—through a process known as "diffusion"—force their way into the metal to

form a microscopic film which can be controlled in thickness to a few millionths of an inch.

The diffusion technique opened the way to three major Bell Laboratories inventions in the semiconductor field: the Bell Solar Battery, Silicon Power Rectifier and the Diffused Base Transistor. Right now the technique is providing a key to many other developments of great promise for telephony. It is another example of how Bell Labs works to improve telephony through fundamental research in materials.

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## Strontium-90 in Man

J. Laurence Kulp, Walter R. Eckelmann, Arthur R. Schulert

Radioactive fallout at great distances from atomic explosions produces both internal and external hazards to the human race. The external hazards result from the interaction of gamma rays in the environment on the genes of individuals, which produces an increased mutation rate. The increase in normal gamma background owing to fallout is very small, so far, and it is being carefully monitored (1). The tolerable level of external gamma radiation for genetic effects is not well defined (2). The internal hazard is primarily the development of bone cancer, because of the presence of strontium-90 (half-life 28 years). Libby (3) has discussed the general problem of strontium-90 in fallout and has presented considerable data (4, 5) on the concentration of this isotope in various parts of the chain from the atmosphere to man.

This article (6) summarizes the results obtained at Lamont Geological Observatory on the strontium-90 content in man (based on a world-wide sampling network) and attempts to evaluate the potential hazard. The work presented here is a part of a more comprehensive study of the geochemistry and biochemistry of strontium-90 that has been in existence at Lamont for several years (7, 8). The first experimental verification of measurable quantities of strontium-90 in animal bone, milk products, and soil was made at Lamont in August 1953 following the prediction by Libby, Eisenbud, and others in July 1953 (9) that it might be found in detectable quantities if low-level techniques were employed.

At the present time strontium-90 can

be found in all human beings, regardless of age or geographic location, provided that a sample of adequate size is available. As is shown here, these quantities are small compared with the maximum permissible concentration (MPC) (1.0 millimicrocuries of strontium-90 per gram of calcium) established by the National Committee on Radiation Protection (10). However, the existence of measurable quantities makes it possible to analyze the present distribution of strontium-90 with regard to age, sex, diet, geography, and time. Such information is fundamental for making predictions about the probable effects of future nuclear explosions.

### Dispersal

The route of strontium-90 from the time of fission to its uptake in human bones is known in broad outline. The explosion releases the strontium-90 into the air, where it is then carried for great distances. Eventually it is transported to the soil and becomes a part of the base-exchangeable alkaline-earth-metal ions in the upper few inches. Since plants take up this radioactive strontium along with their necessary calcium, human beings ingest strontium-90 from vegetables and milk products.

Kiloton explosions produce debris mainly in the lower atmosphere (troposphere), from which the strontium-90 is deposited in a few weeks (5). This debris is deposited in a restricted latitude. Thus the Nevada test series distributed strontium-90 largely over a narrow latitude band in the Northern Hemisphere, with a higher concentration in the United States than elsewhere. Megaton weap-

ons, on the other hand, appear to put most of their strontium-90 into the stratosphere, where it is more or less uniformly distributed with respect to latitude. It then passes very slowly (about 10 percent per year) back into the troposphere (4), from which it is rapidly washed out. Megaton explosions, therefore, tend to equalize the world-wide fallout pattern. The local distribution will be modified by rainfall, vegetation cover, and topography, but the latest total fallout data (1) support a rather homogenous distribution that shows maximum variations of only a factor of 3 at the longitudes of Africa and New York. The distribution in the Northern Hemisphere remains higher than that in the Southern Hemisphere, because of the kiloton shots from the Soviet and United States test sites.

It is now reasonably well established (5) that the scavenging action of rain is responsible for most of the deposition of tropospheric debris. Experiments made at this laboratory during the past 6 months confirm this conclusion. Other experiments at Chicago (11) and at Lamont (8) indicate that at least 60 to 70 percent of the strontium-90 which has fallen out in the United States is in the soluble form and is therefore available to plants. It is suspected that the megaton debris from the Pacific tests has a higher fraction of soluble strontium-90 than debris from other tests, but this remains to be confirmed. About 80 percent of the strontium-90 is found in the upper 2 inches of the soil, but in some cases detectable amounts may be carried down as far as 12 inches (8), because of the type of soil, topography, and drainage pattern. Measurements of the soil and plant content of strontium-90 per gram of available calcium in 1953 (4) can be interpreted as meaning that some plants have significant surface retention of strontium-90, or that the concentration of strontium-90 per gram of calcium in the 0- to 2-inch interval is not representative of the true environment of the roots. As the ground becomes progressively more contaminated with strontium-90, however, the surface effects become obscured. Thus, on the East Coast of the United States during the Nevada tests in the spring of 1955, the surface fallout of strontium-90 was only a very small fraction of the total strontium-90 in the plants (8).

The total fallout of strontium-90 was

The authors are on the staff of Lamont Geological Observatory, Columbia University, Palisades, N.Y.

estimated by Libby (5) at the end of 1955 to be about 13 millicuries per square mile in the upper midwestern region of the United States. The soil data of Hardy and Morse (4) suggest an average of about 15 millicuries per square mile for the United States. On the basis of the fallout of mixed fission products and an estimate of strontium-90 fractionation at long distances from test sites, Eisenbud and Harley (1) calculated a fallout of 13 millicuries per square mile for the United States in late 1955. By comparing the average total fallout on gummed paper for the United States in the fall of 1955 (1) with that for the world, a world-wide average deposition of strontium-90 on the soil of 8 millicuries per square mile can be calculated.

The amount of strontium-90 in the soil which gets taken up by the plant depends on the root depth, the calcium content of the soil, and the biological fractionation factor. Menzel (12) has shown that strontium is discriminated against by a factor of about 1.4 when it goes from soil to plant. The calcium content of the soil varies greatly. Values of 0.4 to 40 milliequivalents of exchangeable calcium per 100 grams of soil are common. Further, as noted in a foregoing paragraph, the concentration of strontium-90 drops rapidly with depth. These factors make it possible for the concentration of strontium-90 per gram of available calcium to vary by a factor of more than 100 for a given amount of fallout. Since the biological hazard may be stated in terms of concentration of strontium-90 per gram of calcium, it is clear, then, that merely to consider average values of strontium-90 in soil is not sufficient. Thus, although the fallout of strontium-90 per square foot in the New York area in 1955 varied by a factor of 7 (144 to 1010), the range in micromicrocuries of strontium-90 per gram of available calcium exceeded a factor of 40 (6 to 250) (8).

## Biochemical Considerations

Most people in the United States obtain their calcium through milk products. Here, fortunately, there is a discrimination factor of 7 against strontium from the plant that the cow consumes to the milk produced, according to experiments by Comar (13).

Regardless of the dietary source (milk products, vegetation, meat, or water), strontium-90 will follow calcium in the body, but it is discriminated against in going from the intestines to the blood by a factor of 2 to 3 (14, 15). Studies on human beings who have been given intravenous tracer doses of strontium-85 and calcium-45 simultaneously show that strontium is also discriminated against in the process of bone deposition. This, together with the fact that the body preferentially excretes strontium, results in a progressive enrichment of the bone in the calcium isotope following a single administration of the two tracers, the experimentally determined factor being 2.0 at 1 month and gradually increasing (16). On constant dietary intake, it would appear that an equilibrium enrichment of about 3 would be obtained in going from blood to bone, so that the total discrimination against strontium in going from the food to bone is about 8.

Appreciable local variations in strontium-85 content per gram of calcium occur in individual bones after a single dose. The "hot spots" that appear on autoradiographs are probably of less consequence in the case of strontium-90 than they are in the case of radium, because the dimension of these localizations is usually much less than the range of the beta particle that is emitted from the strontium isotope. Table 1 shows that real differences in strontium-85 content per gram of calcium exist among the various bones of a particular skeleton. Although the data shown are for an individual who died 39 days after administration, the ratios proved to be relatively

uniform for seven other cases ranging from 3 hours to 125 days.

From the unpublished data of Trotter on the weights of individual bones in the human skeleton and from information on the percentage of calcium in the bones and the distribution of strontium-85, it is possible to calculate the total skeletal load of strontium-90 from any given bone. The bone most frequently obtained at autopsy is the rib. It may be noted from Table 1 that the concentration of strontium-85 per gram of calcium in the rib is twice that of the average body. Other bones frequently received in the world-wide survey are femur and vertebrae, which contain 0.72 and 4.2 times the average strontium-85 concentration of the whole skeleton, respectively.

These are the primary concepts and data that must be used in interpreting the world-wide human assay.

## Sampling

Autopsy samples of human bones were obtained from 17 stations in a world-wide network (17) (Fig. 1). To date, more than 1500 samples have been received, and about 600 analyses have been made; the bulk of the samples have come from about ten stations. The size of sample ranged from 1 to 200 grams of wet bone. An attempt was made to get as wide a geographic and dietary distribution as possible, but the distribution was necessarily limited by our contacts with physicians in certain centers. Future sampling will utilize a wider network, and considerable use will be made of integrated samples.

The bones employed were usually ribs, but those from Germany were femur shafts, and those from Switzerland, England, and Denmark were vertebrae. In all cases the entire rib, shaft, or vertebrae section was ashed and analyzed to avoid local variations that do appear both laterally and vertically in the bone.

The early results suggested that there was negligible strontium-90 in persons over 40 years of age; hence, sampling was concentrated in the younger age groups. It is clear that this is no longer true and that a broader spectrum is now desirable.

A few samples of adult bone measured at Lamont and many stillborns analyzed at Chicago (4) date as early as 1953, but for most localities the samples were procured in 1955, so that a clear definition of the rate of change of strontium-90 concentration cannot yet be made.

## Analysis

The radiochemical procedure (18) consists briefly of ashing the bone, dissolving in hydrochloric acid, precipita-

Table 1. Relative size of bone and distribution of strontium-85 in human skeleton.

Bone	Percentage of skeleton (dry wt)*	Percentage of calcium of skeleton	Percentage of Sr <sup>85</sup> per gram of calcium†
Long bones‡	52.5	57.9	0.0187
Femur	18.7	20.6	0.0219
Humerus	6.9	7.6	0.0171
Radius	2.3	2.5	0.0170
Skull and mandible	17.9	19.7	0.0094 (skull)
Rib	5.7	6.3	0.0618
Vertebrae	8.6	7.1	0.128
Sternum	0.3	0.2	0.138
Weighted average			0.0303

\* Data kindly supplied by Mildred Trotter, Washington University School of Medicine.

† Data from Schuler, Laszlo *et al.*, giving concentrations 39 days after administration of isotope. Other data taken from 3 hours to 125 days after administration of isotope show similar relative distribution of strontium-85.

‡ All the limb bones plus the pelvis. In averaging, it was assumed that the three analyzed are representative of the total.





Fig. 1. World-wide network for collection of human bone samples. The triangles indicate new stations for which data are not yet available.

ting calcium oxalate, igniting to calcium oxide, resolving in hydrochloric acid, adding nonradioactive yttrium carrier, and milking the yttrium-90 daughter of strontium-90 as the oxalate. Usually the first milking brings down some foreign activities so that a second one is required for the quantitative assay of yttrium-90. Purity is checked by monitoring the decay of the yttrium-90 precipitate. The yttrium oxalate precipitate is counted in a convenient low-level system that has been described elsewhere (19). This procedure makes it possible to determine less than 1 disintegration per minute of the strontium-90 sample. At the level of 10 disintegrations per minute, per sample, the precision is a few percent. Even at low levels of activity, the variation in the individual samples is considerably larger than the experimental error.

The data reported in this paper were obtained at the Lamont Observatory and at two commercial laboratories: Isotopes Incorporated, Westwood, New Jersey; and Nuclear Science and Engineering Corporation, Pittsburgh, Pennsylvania.

## Results

All of the analyses of strontium-90 in human bone reported in this study are summarized by locality in Fig. 2. The results are given in micromicrocuries of strontium-90 per gram of calcium. The dashes mean that the sample contained

equal to, or less than, this amount. The error in a determination is generally less than 20 percent, but for a few of the very small samples or those with only a few hundredths of a micromicrocurie of strontium-90 per gram of calcium, it may be considerably higher.

Table 2 shows the averages for all localities broken down into age groups. All values in this table are normalized to an average skeleton, using the aforementioned factors. The weighted averages for each age group were calculated for each continent and for the world. Finally, a total maximum world average of the concentration of strontium-90 in the human skeleton was obtained. The average deviation for a given age group and locality was commonly around 50 percent. All samples whose analyses were reported as "equal to or less than  $x$ " have been assumed to contain  $x$  micromicrocuries of strontium-90 per gram of calcium for the purposes of this averaging. Thus Table 2 actually represents the maximum average strontium-90 content. For most localities, however, this makes little difference, because the number of such analyses was small or the analyses were in the range of low concentration. In the case of Chile and Brazil, however, the actual average concentration is probably about 25 percent lower than this maximum value.

One sample with very high concentration of strontium-90 was not included in the average. This sample was from

Vancouver, British Columbia (49 years; tibia), and it had a concentration of  $6.6 \pm 0.3$  micromicrocuries of strontium-90 per gram of calcium. This would give a skeletal average of about 9.1 micromicrocuries of strontium-90 per gram of calcium. Analytic error owing to contamination appears unlikely, since other samples that were processed at the same time showed very low activity.

## Discussion

From the analytic data shown in Fig. 2 and Table 2, the following tentative conclusions may be drawn.

1) The present world-wide average content of strontium-90 in man is about 0.12 micromicrocuries per gram of calcium, or 1/10,000 of the presently accepted maximum permissible concentration.

2) The averages for the different continents are surprisingly similar, indicating that already the stratospheric drip of strontium-90 from megaton explosions is swamping the local concentrations from both the Nevada and the Soviet test sites. There is evidence, however, that Chile and Brazil have clearly lower concentrations than those localities in the Northern Hemisphere for which a large number of samples are available. The close similarity between Houston, Texas, and Bonn, Germany, for which good sampling is available, emphasizes that

the differences as a function of longitude in the Northern Hemisphere are small. Since Taiwan has appreciable fallout from Pacific and Soviet tests (1), it is not surprising that its values are similar to those for North America.

3) There is clearly an age effect, at least in the first 20 years. Young children

have 3 to 4 times more strontium-90 per gram of calcium, on the average, than adults. This effect reflects the larger proportion of active bone in children.

4) As was expected, the average strontium-90 content of human bone does not vary from one locality to another more than the average concentration of mixed

fission products (1). For identical periods of time there is a fair correlation between these two factors for the 17 localities that were sampled for human bone.

5) By averaging all samples from persons above 10 years of age, a large enough set is available for comparison between localities. In North America, for exam-

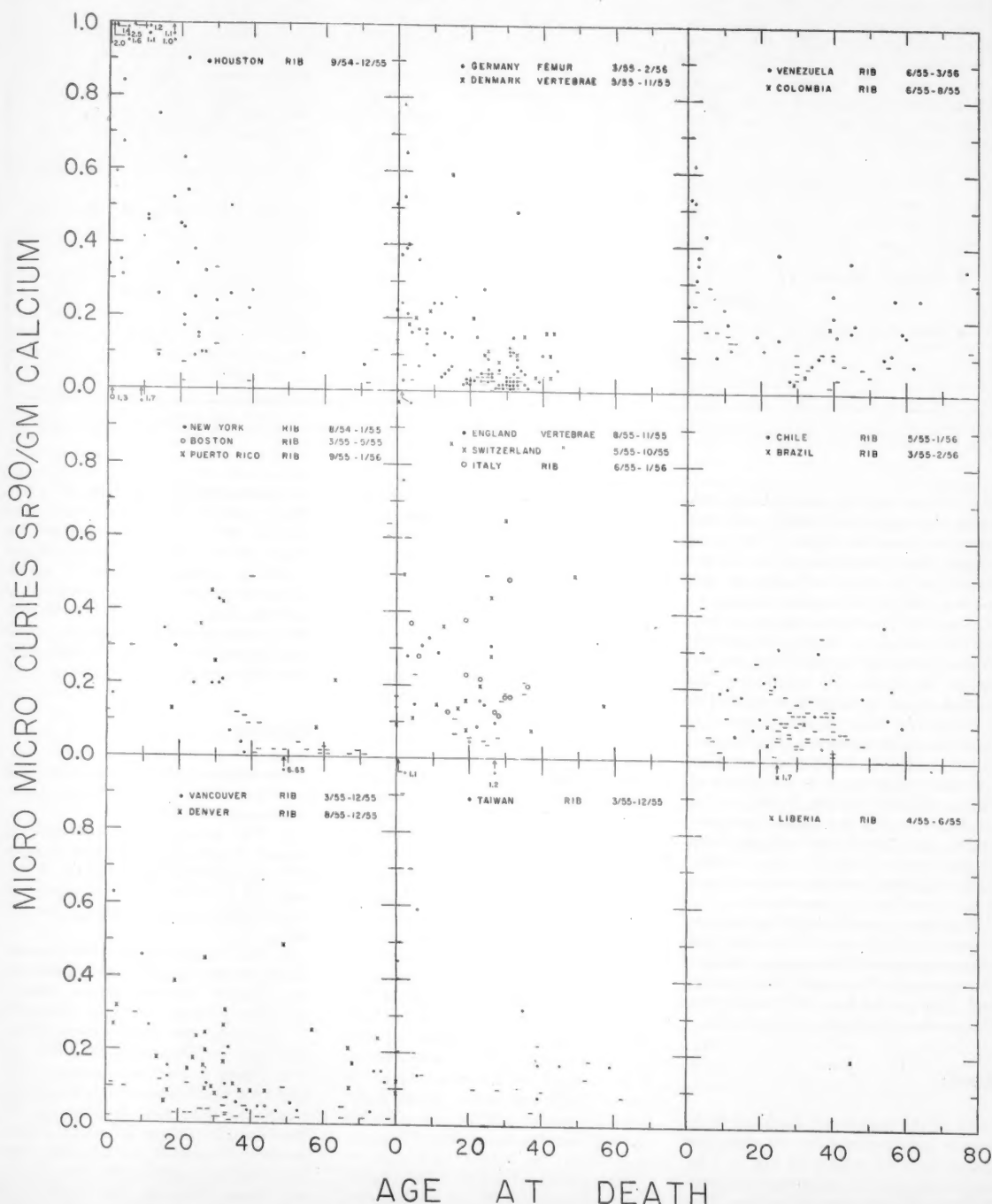


Fig. 2. Strontium-90 content of human bone in 1955.

ple, it is readily seen that the concentration in Vancouver is essentially the same as that in Houston, whereas the concentration in Denver is definitely lower (despite its proximity to Nevada). The New York average is not strictly comparable; it is low because samples from individuals 40 to 60 years of age comprised half of the total. These are the only ones in the table that were obtained in the spring and fall of 1954. At that time the strontium-90 content of adult bone was distinctly lower than it was in late 1955. (Note that the concentration in New York City milk had increased at least by a factor of 2 toward the end of 1955 from the level in 1954 (4).

6) There are large deviations from the mean in the strontium-90 content in individuals of a given locality. The average deviation for most 10-year-age sets is about 50 percent. Figure 3, a log normal plot of the North American samples, illustrates that some individuals may have at least 10 times the average concentration. This is most probably related to diet.

An attempt was made to find the time-dependence of the strontium-90 contamination in human bone. The major difficulty is the limited time interval over

which samples have been taken (mainly 1955). The New York samples of the spring and summer of 1954 in the older adults (40 to 60 years) were definitely lower (the average was less than 0.01 micromicrocurie of strontium-90 per gram of calcium) than in areas of similar total fallout in 1955—for example, Puerto Rico and Denver (averages were 0.14 and 0.08 micromicrocurie of strontium-90 per gram of calcium, respectively). Here an increment of 0.1 micromicrocurie of strontium-90 per gram of calcium, per year is evident. It now appears that stillborns may have a higher concentration than the average of the mother skeleton, at least during this early period of nonequilibrium. The Chicago data (4) suggest a 1953 stillborn average of about 0.12 micromicrocurie of strontium-90 per gram of calcium; this climbed to 0.17 by the spring of 1954. Six samples from Chile gave about 0.35 in mid-1955. The values for the comparable mother skeletons would have been 0.03 micromicrocurie per gram in Chicago in 1954 and 0.07 micromicrocurie per gram in Chile in 1955.

The samples from Germany were of sufficient size and number to make possible a significant comparison between

the periods March to September 1955 and October 1955 to January 1956. The biggest difference was observed in the youngest age group, whose members would be the most sensitive to change in the strontium-90 concentration of the diet, because of their rapid growth. For the 0 to 9 age group, the averages were 0.21 and 0.34 micromicrocurie of strontium-90 per gram of calcium for March to September 1955 and for October 1955 to January 1956, respectively. A major increment in the known bone data should be observed in the present winter 1956-57 collection.

The average American obtains about 80 percent of his calcium from dairy products and the remainder mainly from vegetation (20). In 1955 the strontium-90 concentration in milk in the United States was about 3.5 micromicrocuries per gram of calcium (4, 5). During the same period, field vegetation averaged about 20 micromicrocuries per gram of calcium (5, 8) so that the average human population in the United States probably had a diet of about 7 micromicrocuries of strontium-90 per gram of calcium. Using the discrimination factor of 8 between diet and human bones, an equilibrium concentration of

Table 2. Average strontium-90 content in man 1955. (All values in micromicrocuries of strontium-90 per gram of calcium, normalized to the average whole skeleton. The numbers in parentheses give the total number of samples in the category.) The world average for all ages and locations is 0.12 micromicrocuries per gram of calcium; the average, including one sample of high value, is 0.14; and the world average for all samples assuming "equal to or less than" values are zero is 0.10.

Location and sample	Age at death								Average 10-80
	0-4	5-9	10-19	20-29	30-39	40-49	50-59	60 →	
<i>Europe</i>									
Germany (femur)	0.44(12)	0.25(6)	0.14(13)	0.065(33)	0.085(29)	0.14(2)			0.085(77)
Switzerland (vertebrae)	0.13(3)		0.068(6)	0.076(3)	0.088(2)	0.12(1)	0.036(1)		0.076(13)
England (vertebrae)	0.19(3)	0.060(4)	0.048(2)	0.026(9)					0.032(11)
Denmark (vertebrae)	0.044(1)	0.052(2)	0.14(1)	0.029(4)	0.024(3)	0.029(4)			0.036(12)
Italy (rib)	0.18(1)	0.14(1)	0.10(4)	0.10(6)	0.11(7)				0.11(17)
Average	0.33(20)	0.15(13)	0.11(26)	0.06(55)	0.085(41)	0.08(7)	0.04(1)		0.078(130)
<i>North America</i>									
Texas (rib)	0.49(13)		0.22(9)	0.14(17)	0.12(8)	0.13(1)	0.05(1)		0.15(36)
Denver (rib)	0.12(5)	0.085(5)	0.09(11)	0.075(9)	0.09(4)	0.13(1)		0.07(7)	0.085(32)
New York City (rib)	0.44(2)	0.16(3)	0.17(2)	0.10(2)	0.075(8)	0.005(4)	0.01(4)		0.06(20)
Boston (rib)	0.40(2)								
Vancouver (tibia)	0.46(2)		0.28(5)	0.10(4)	0.066(11)	0.06(5)	0.06(3)	0.092(7)	0.10(35)
Puerto Rico (rib)	0.06(1)		0.065(1)	0.21(2)	0.13(3)	0.15(2)	0.04(1)	0.16(6)	0.14(15)
Average	0.41(25)	0.12(8)	0.17(28)	0.12(34)	0.09(34)	0.07(13)	0.02(9)	0.10(20)	0.11(138)
<i>South America</i>									
Colombia (rib)				0.016(1)	0.04(5)	0.04(1)			0.035(7)
Chile (rib)	0.15(1)	0.06(5)	0.075(7)	0.07(16)	0.06(22)	0.05(10)	0.10(4)		0.065(59)
Brazil (rib)	0.21(1)		0.14(1)	0.055(1)	0.055(1)	0.05(3)			0.06(12)
Venezuela (rib)	0.19(10)	0.11(4)	0.08(4)	0.085(4)	0.04(6)	0.085(10)	0.065(6)	0.105(6)	0.075(39)
Average	0.19(12)	0.085(9)	0.08(15)	0.07(27)	0.055(34)	0.065(24)	0.08(10)	0.105(6)	0.065(117)
<i>Africa</i>									
Liberia (rib)				0.83(1)		0.093(1)			
<i>Asia</i>									
Taiwan (rib)	0.34(5)	0.16(3)	0.25(1)	0.33(2)	0.08(7)	0.055(3)	0.08(3)		0.12(16)
<i>World-wide</i>									
Average	0.31(62)	0.14(33)	0.12(70)	0.09(118)	0.08(106)	0.07(47)	0.06(22)	0.09(26)	

about 0.9 micromicrocurie of strontium-90 per gram of calcium would be predicted for the average American. The actual concentration in 1955 was probably about 0.3 for young children and 0.1 for adults. These lower values reflect the time required for bones to equilibrate with the strontium-90 calcium ratio in the diet.

An estimate of the world-wide burden can be made by assuming that the average total strontium-90 fallout was 8 millicuries per square mile in 1955, and that the average amount of exchangeable calcium is 75 grams per cubic foot (4). Thus, if half of the fallout is in the upper 1 inch of soil, which contains 6 grams of calcium per square foot, an average concentration of about 25 micromicrocuries of strontium-90 per gram of calcium would be available to grains and grasses. Using a soil/plant fractionation of 1.4 and a plant/milk fractionation of 7, the average world-wide concentration of strontium-90 in milk would be about 25 micromicrocuries per gram of calcium, and in vegetation about 18 micromicrocuries per gram of calcium. Assuming that 80 percent of the world-wide dietary calcium comes from milk products—as is true for the average American diet (20)—the predicted concentration of strontium-90 in the diet would be about 5 micromicrocuries per gram of calcium. This in turn would yield a predicted value of 0.6 micromicrocurie per gram of calcium for the average man when equilibrated with the fallout that existed at the end of 1955. The major uncertainties in the calculation are the source of calcium in the average world diet, the average calcium content of the soil, root depth, and possible direct foliar uptake.

In terms of hazard to man, there are two problems to be considered: (i) the average value for the world population and (ii) possible maximal concentrations. Locations near atomic test sites are not included in these considerations.

With regard to the strontium-90 burden of the population of the world in the fall of 1955, it can now be said that this is reasonably well known (0.12 micromicrocurie per gram of calcium) and that this burden is very small compared with the maximum permissible concentration (1/10,000).

The matter of predicting the maximum average human burden that will ultimately be occasioned from atomic explosions through the fall of 1956 involves several factors. The average burden will be determined by the average strontium-90/calcium ratio in the diet at equilibrium. Thus, if the fall 1955 concentrations in the diet were maintained, the average human being at all ages would reach a maximum of about 0.6 micromicrocurie of strontium-90 per gram of

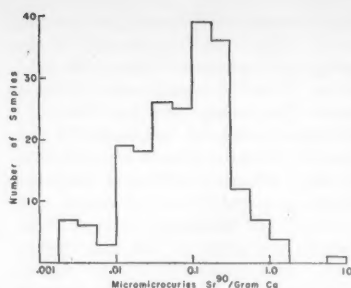


Fig. 3. Distribution pattern of strontium-90 in human bone in North America.

calcium. This would be the result of a world-wide fallout of about 8 millicuries per square mile by the end of 1955 (1). From the end of 1955 to the fall of 1956, another 2 millicuries per square mile would appear world-wide from stratospheric fallout. An additional 8 millicuries per square mile has fallen out since 1955 from high-yield weapons that have deposited all of their debris in the Northern Hemisphere (5). Libby (5) states: "In fact, we estimate at the present time that the total stratospheric reservoir, counting all sources, is about the same as it was 2 years ago—that is, 12 millicuries of strontium-90 per square mile, or the equivalent of 24 megatons of fission products calculated as a uniform world-wide distribution." Taking decay into account, a total quantity of 26 millicuries per square mile would be available in the United States for equilibration with the human skeleton by 1970. Thus, from explosions that have already occurred, the average human bone in the United States should contain about 2 micromicrocuries of strontium-90 per gram of calcium by 1970, whereas the world-wide average concentration should be about 1.3. This will have been the result of about 50 megatons of fission. On this basis, 35,000 megatons of fission would be required to bring the average concentration in the world's population up to the maximum permissible concentration.

The most important problem lies with individual variation. By direct experiment, it has been found that the distribution curve is quite sharp (Fig. 3 and Table 2). Although food grown in restricted areas of low available calcium content could have 10 to 100 times the mean, it is clear that the general mixing of food sources in the diet of an urban population would make it impossible for most people of the world to exceed the average concentration of strontium-90 by more than a factor of 10.

The theoretical estimation of the maximum concentration of strontium-90 that some individual or a small group of individuals might receive at long distances

from atomic test sites is a complex problem involving a number of parameters that are at present subject to large uncertainties. The highest concentrations will be found in isolated individuals who obtain their total food supply from a restricted area that has very low available calcium in the soil (21).

## Summary

The world-wide average strontium-90 content of man was about 0.12 micromicrocurie per gram of calcium (1/10,000 of the maximum permissible concentration) in the fall of 1955. A few values as high as 10 times the average have been obtained.

This value is in accord with the predicted value based on fallout measurements and fractionation through the soil-plant-milk-human chain.

With the present burden of strontium-90, this average level should rise to 1 to 2 micromicrocuries of strontium-90 per gram of calcium by 1970.

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6. This article is Lamont Geological Observatory contribution No. 231. This research was supported by the Division of Biology and Medicine of the U.S. Atomic Energy Commission. We wish to acknowledge the very substantial contribution of many medical scientists who cooperated so willingly in procuring the autopsy material.
7. This research was initiated at the suggestion of W. F. Libby. The encouragement, support and criticism of W. D. Claus, F. Western, R. A. Dudley, and D. L. Wolf of the Division of Biology and Medicine and M. Eisenbud, J. Harley, and J. Whitney of the New York Operations Office are much appreciated. We also wish to acknowledge the scientific contributions of H. L. Volchok of Isotopes Inc. and W. S. Broecker and K. K. Turckian of this laboratory. Laboratory assistance was provided at various times by J. E. Gaefjen, E. Hitchcock, E. Hodges, P. Kluff, A. Long, R. Lupton, R. Jones, E. Peets and R. Slakter.
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- been in the soil for long periods compared with the laboratory experiments; hence near equilibration appears probable. (iv) Other workers have recently reported experiments that gave about 1.4 [K. Larsen, *UCLA Rept. No. 380* (6 Nov. 1956); H. I. Bowen and J. A. Diamond, *J. Exptl. Botany* 7, 264 (1956)].
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## Science, Ethics, and Politics

Albert Szent-Györgyi

We are often told that science has no moral content. Certainly, if I measure the respiration of a tissue, I have little to do with morals or ethics, but on the same ground one could deny a religious content to the Holy Communion, drinking wine and eating bread not being, in themselves, religious acts. If there should be a Creator, then scientific research would be tantamount to worship, there being no greater compliment to a creative artist than an effort to understand his work.

The scientist is searching for truth, for truth's sake, and, if it is found, he processes it without fear of consequences. This demands the highest ethical standards and brings him into line with the religious and moral leaders of mankind. What the scientist really wants to know are the internal laws that hold the universe together with all that is in it. Morals are the laws that hold human societies together. So science is not devoid of relations to ethics and morals.

### Moral Law

Morals are practical prescriptions that tell us how to live to be able to live together. The moral outlook of a scientist has to be wider than that of the average, simply because his society is wider, not being limited by time or space. The community in which I live has Galileo, Newton, and Lavoisier as its active members, and I cannot help feeling more affinity to Chinese or Indian scientists than I do to my own milkman.

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As to politics, up till lately, there was no need for the scientist to take cognizance of its existence. However, lately, politics has penetrated not only into science but also into the private lives of individuals, forcing the scientist, too, to make a stand. That science, in certain countries, is dictated by political dictators is so crude a matter that it demands no discussion.

A subtler question may be asked about the aims of science. The main driving force of researchers is mostly some sort of a curiosity, the gratification of a mental need, which makes research a selfish occupation. However, from a higher point of view, scientific research is one of the human efforts aimed at elevating man. Within the last decade, science has created the most powerful tools, which, like any tools, can be used for construction or destruction. The scientist cannot remain a neutral spectator and refuse all moral responsibility when he sees the politician run away with these and turn them into tools of destruction.

We all have the bad luck to be born in an age of a moral crisis, and, according to Dante, the hottest places in Hell are reserved for those who remained neutral at times of a moral crisis. So we all have to take a stand, simply as human beings. Humanity has its well-established moral code on which human relations are based. It is these moral laws that enable man to live in a society, and the problem is whether these morals apply only to the individual or also to groups of men, whether crimes which are punished by death in one country should be suffered to be practiced on a big scale as a routine by governments in another country, being "internal affairs." This is more than an

ethical problem. As a society could not exist without a moral convention among its members, so countries cannot exist, side by side in peace, without a moral code. I am deeply convinced that this is the simple root of all our political troubles, the whole political superstructure being but a "pseudo-problem."

### One Moral Code

I also believe that there cannot be two moral codes, an individual one and a political one. There is but one, and this one is very deeply written into our minds by our education. It is so deeply engraved that we see no need to restate it every time we make any agreement, and we tacitly suppose all written agreements to be based on this unwritten moral code. For instance, if we make an alliance, we see no need to state explicitly that it is made so that we may help one another and not to enable us to stab our ally in the back, as we were advised to do by Lenin.

It is natural that any system can achieve a great temporary advantage by rejecting the moral code that is written so deeply in its adversary's mind that he will believe and fall, over and over again. How often the world believed, *ad nauseam*, when Hitler called every demand his last one. The Hungarians fell for the famous "salami technique" (one slice at a time). We saw just the other day, how, with a boring repetition, all leaders of a revolution could be trapped and marched to jail by an invitation to a "discussion."

There is but one moral code, and, if any government rejects it inside its borders, it will reject it in its international relations as well and create disorder. The question is whether any deviation from moral convention should be suffered by the rest of mankind. There are international laws to control pestilence, for fear that that pestilence may spread across borders. Why not the same for moral pestilence?

### Political Questions and the Individual

For most of my colleagues, these questions may seem so crude, and the an-

swers so self-evident, that discussion of them is superfluous. But, political questions can come into the scientist's life also in subtler forms, making decisions more difficult. Let me illustrate from my own experience.

Before the war, in Hungary, my home country, the government often invited from abroad scientists whom I was glad to receive, until I found that the invitations followed a political pattern and were thus a part of a political plot, of which I was made an instrument. After the war I was treated by the Soviet Government with utmost kindness and distinction, which obliged me to the deepest gratitude. What was I to do later, when I found the methods of the Soviet rule based on moral principles contrary to my own? Was I to trade morals for gratitude? A difficult choice, indeed, for gratitude itself has its moral aspect. And finally, should I follow the invitation to see my colleagues and discuss, say, the origins of life and accept the hospitality of a government when I know that it will make out of that conference political capital, and when the dealings of that government recall not colonialism, but the darkest days of African slave trade?

These are subtle and difficult questions, but we have to make order in our minds, make a stand to avoid being made into tools of politics with which we may disagree. Everyone will have to answer these questions for himself. What I wish to do here is to call the attention to three psychological factors that may make the choice difficult and obscure the issue unless we have recognized them.

The first of these can be summed up by the saying, "things are not as we see them, but we are as we see things." An

honest man will think the world honest; a dishonest man, or government, will think that the rest of the world is made of criminals or warmongers. This is natural. We really know only our own mental machine and are likely to suppose that it represents *the* mental machine of man. So, if honest people hear and read about crimes committed in other countries, they just do not believe it, or may believe it with their minds only, not with their hearts. How far this is true is shown by the Communist trials in which Stalin had most of his comrades executed. The whole world listened to the confessions of guilt, and it occurred to nobody that all this may be just the result of a new invention, brainwashing.

Another peculiarity of the mind is that man likes to commit his crimes and gratify his animal instincts, or craving for power, in the name of high-sounding principles. So, we cook up such principles and appoint ourselves their defenders. Men of good will thus are sidetracked, giving their honest consideration to the principles instead of to the crimes. Even good ends do not justify bad means, so I keep myself to the advice, "watch deeds, not words." In politics, I observe "acts" and lend a deaf ear to "principles" until my moral standards have been satisfied by the former.

My third, and last, remark concerns the fact that the brain is not an organ of thinking, but an organ of survival, like claws and fangs. It is made in such a way as to make us accept as truth that which is only advantage. It is an exceptional, almost pathological constitution one has if one follows thoughts logically through, regardless of consequences. Such people make martyrs, apostles, or scientists, and

mostly end on the stake or in a chair, electric or academic.

In my home country, in the turmoil of the last decades, it was almost impossible for anyone who followed thoughts through to their bitter end to survive. Those, for instance, who took Christian doctrine seriously and refused to kill were themselves killed. I myself had the great honor to be declared a traitor by my Government twice—in opposite directions—within one decade. I have seen men of good faith believe the craziest *nonsense* once it brought jobs. So the scientist, when trying to make up his mind, should not give too much credence to the words *faith* or *creed*, either in himself, or in others.

Another difficulty may lie in the fact that moral laws are not always unequivocal. If morals are the rules which make living together possible, then they may change according to the conditions under which we have to live together. Bigamy is regarded as a crime in one country, while in another it may be the rule for any self-respecting gentleman. Even the most basic rule, "Thou shalt not kill," may change from time to time. At the dawn of mankind it might have read, "Thou shalt not kill inhabitants of your own cave." Politicians would like to keep it at this level.

So, what is really needed is an international "bureau of moral standards," passing out "weights and measures." If these were generally enforced or accepted, we would march toward a more hopeful future and would not have to find consolation in the fact that, after all, our globe is but a second-rate planet and so its blowing up does not really matter.



## News of Science

### Gorilla Born in Captivity

On the morning of 22 Dec. 1956, a gorilla was born in the Columbus (Ohio) Zoo. This is a particularly noteworthy event, for the little female ape is the first gorilla known to have been born in captivity. Births of chimpanzees in captivity have become relatively common occurrences, and similar births of orang-utans are less common but not extremely rare. Hence, all of the three great apes have now been born while under confinement by man.

A full, official account of this epochal event is not yet available; but certain pertinent details have been published in the newspapers and popular magazines. Weight of the newborn gorilla is given as both 4.5 pounds (according to both Associated Press and United Press dispatches published 23 Dec. 1956) and 3.25 pounds (*Life*, 14 Jan. 1957). The gestation period is reported to have been 258 days (*Life*) or 259 days (AP and the *New York Times*, 23 Dec. 1956). The mother weighs either 260 pounds (UP and *Life*) or 280 pounds (AP), and she is said to be 9 years old (all three sources). The father weighs either 380 pounds (*Life*) or 400 pounds (AP), and his stated age is 11 years (all three sources).

According to one report (UP), the birth was "apparently premature." The basis for this diagnosis is not clear. Presumably, it rests on the birth weight of the infant. If so, however, such a conclusion may not be justified. Reichenow [*Real Soc. Espan. Hist.*, T. Extraord. (1921), pp. 337-348] captured a baby gorilla that was probably only a few days old and weighed only 2 kilograms (4.4 pounds), a weight which agrees with that first reported for the Columbus infant. A young gorilla captured by Famelart [*Bull. Soc. Zool. France* 8, 149 (1883)] was estimated to be 7 months old, yet it also weighed only 2 kilograms. (It seems likely that Famelart's estimation of age was too high; however, according to Schultz [*Mem. Carnegie Mus.* 11, 1 (1927)], this animal must have been at least 2 months old, on the basis of the teeth that had erupted.)

From these observations, plus additional data published by Brandes (1930),

Schultz concluded that the newborn gorilla does not exceed 2 kilograms [*The Anatomy of the Gorilla* (New York, 1950), pt. 5, pp. 227-248]. Indeed, of all the simian primates studied, the gorilla weighs relatively the least at birth. The average weight of the newborn in percentage of the weight of fully adult females is 2.4 for the gorilla, 5.5 for man, 4.0 for the chimpanzee, 4.1 for the orang-utan, 6.0 for the siamang, 7.5 for the gibbon, 4.6-7.0 for various Old World monkeys, 7.0-8.5 for several New World monkeys, and 4.6 for the true lemur [Schultz, *Primatologia* 1, 887 (Basel, 1956)]. This is not surprising, since among species that are closely related the larger ones usually have relatively the smallest babies (Schultz, 1956).

No competent student of primates would seriously doubt the close relationship of gorillas and chimpanzees, which, indeed, at times have been regarded as no more than different species of one and the same genus. Taking the weight of the newborn Columbus gorilla as 4.5 pounds and that of its mother as 260 pounds, one obtains a relative birth weight of 1.7; or, if the mother's weight was actually 280 pounds, 1.6. Although these values are somewhat less than the value given by Schultz (2.4), prematurity is not necessarily indicated; one has only to consider the variability of the birth weight of the normal full-term human newborn. If, however, the weights of the gorilla newborn and mother were actually 3.25 pounds and 260 pounds, respectively (as was stated in *Life*), the resultant ratio (1.25) might well indicate a somewhat premature birth.

The claimed length of the gestation period, 258 (*Life*) or 259 days (AP and *New York Times*), is of considerable interest, since it is the only estimate available for the gorilla. This at best can be accepted as the possible maximum for the Columbus birth, and it is not improbable that the actual length of gestation was somewhat less. For this gestation period has presumably been estimated from the very day on which the parents were first put together in the same cage (*Life*! It is this sort of reckoning that has produced at least some of the impossibly high estimates of ges-

tation duration for various primates and other mammals that can be found scattered in the literature. Regarding the reported Columbus estimate, one must await official publication to learn whether records of the mother's menstrual periods and other related, pertinent data have been recorded before deciding about its probable validity. A gestation period of 258 or 259 days for the gorilla, or even a bit less, would be consonant with the existing data for the other giant primates—man, chimpanzee, orang-utan—even if one regards the Columbus birth as slightly premature. The gestation period (from conception to birth) averages approximately 266 days for man, 231 (range 202-261) days for the chimpanzee [Yerkes, *Chimpanzees* (New Haven, 1943), based on 44 normal births at the Orange Park, Fla., primate laboratories], and 273 days for the orang-utan (Schultz, 1956). Lengths of periods, if figured from the last menstruation, would be approximately 2 weeks greater.

The gestation periods of other primates investigated are considerably shorter. The gestation period of the small anthropoid ape, the gibbon (*Hylobates*), appears to be about 210 days (Schultz, 1956). The period of the closely related siamang, *Symphalangus*, is not known). For Old World monkeys of the subfamily Cercopithecinae, reliable determinations (from conception to birth) apparently have been made only for several species of macaque—namely, for rhesus monkey, *Macaca mulatta*, 164 (146-180) days [Hartman, *Contribs. Embryol. Carnegie Inst. Wash.* 23, 1 (1932)]; the crab-eating macaque, *M. irus*, 167 (154-180) days [Spiegel, *Arch. Gynäkol.* 177, 590 (1950)]; the bonnet macaque, *M. radiata*, 163 (153-169) days [Hartman, *J. Mammal.* 19, 468 (1938)]; and the pig-tailed macaque, *M. nemestrinus*, 171 days [Zuckerman, *Proc. Zool. Soc. London*, 593 (1931)]—and for the hamadryas baboon, *Papio hamadryas*—which has a gestation period averaging 172 (154-185) days [Zuckerman and Parkes, *Proc. Zool. Soc. London*, 139 (1932)]. Length of gestation in the closely related subfamily Colobinae has been said to be greater; but more detailed and more precise studies are needed.

In the marmoset, *Callithrix jacchus*, and the tamarin, *Leontocebus rosalia*, small monkeys belonging to the New World family Callithricidae, the gestation period is reported as 140 to 150 days [Lucas, Hume, and Smith, *Proc. Zool. Soc. London* 107, 205 (1937); Asdell, *Patterns of Mammalian Reproduction*, (Ithaca, N.Y., 1946)]. According to Jennison [*Table of Gestation Periods and Number of Young* (London, 1927)], the period is 139 days in the larger New World monkeys of the family

Cebidae—*Ateles paniscus*, *Alouatta seniculus*, *Cebus apella*—and thus approximately the same length as that of marmosets and tamarins; but, in view of the unacceptable estimates that this author gives for some other mammals, these values are certainly open to question.

Published estimates of gestation length in lemurs vary widely, and most of these must be viewed with suspicion. The values for the true lemur (*Lemur*), about 126 days (Schultz, 1956, collected from various sources), and for the lesser galago (*Galago senegalensis*), about 120 days (that is, 4 months) [Lowther, *Zoologica* 25, 433 (1940)], are probably reliable. The gestation period of *Tarsius* is quite unknown. In the tree-shrew, *Tupaia*, which may or may not be regarded as a primate, depending on one's point of view, the period is said to be only 3 weeks, as in rats and mice [Mann, *Ann. Rept. Smithsonian Inst. for 1953* (Washington, D.C., 1954)].

The reported ages of the Columbus gorilla parents, 9 years for the mother and 11 years for the father, if even approximately correct, indicate that both of these animals are young adults. According to data collected by Schultz (1956), menarche in the gorilla female occurs at 9 years, and completion of growth in length in the gorilla male occurs at 11 years. Yet it must be realized that the estimated ages of these Columbus gorillas at best are reasonable approximations; for the animals are said to have been brought to this country only 6 years ago [AP dispatch in *Baltimore Sun*, 23 Dec. 1956]. Their reported weights—380 or 400 pounds for the male and 260 or 280 pounds for the female—are of little help in age diagnosis. Captive gorillas, moreover, tend to be much heavier than wild-shot ones, owing probably at least in part to accumulation of fat as a result of inactivity.

WILLIAM L. STRAUS, JR.  
*Johns Hopkins University*

### Archbold Expedition to New Guinea

Leonard J. Brass, associate curator of the American Museum of Natural History, has reported that the fifth Archbold Expedition to New Guinea has successfully concluded 10 months of field work in the D'Entrecasteaux Group, Woodlark Island, the Louisiade Archipelago, and the Trobriand Islands in the Territory of Papua. Brass, the leader and botanist, says that important collections of plants and mammals were obtained from all of the larger islands. Russell F. Peterson was responsible for the mammal collection, which will be of great interest in the speciation studies in progress at the American Museum of Natural History. Insects, amphibians, reptiles, fresh-water

fish, and mammalian ectoparasites were also collected.

During the past 25 years Archbold Expeditions have been carrying out the systematic biological exploration of New Guinea and the adjacent islands. In 1948 an expedition also investigated the Cape York Peninsula of Queensland, Australia. Brass has participated in all six of these expeditions. His botanical collections go to the Arnold Arboretum, which in turn distributes the material to the other important herbaria throughout the world. Richard Archbold, Research Associate of the Museum, and head of the Archbold Biological Station near Lake Placid, Fla., is the sponsor of these expeditions.

### Thermophysical Properties

On 1 Jan. Purdue University established a Thermophysical Properties Research Center with two long-range objectives: (i) to serve as a world center for the collection, analysis, correlation and dissemination of data on thermophysical properties; (ii) to provide unique facilities and opportunities for graduate study and research on thermophysical properties. The program is under the immediate direction of Y. S. Touloukian, professor of mechanical engineering. Administration of the program will be handled by the School of Mechanical Engineering (H. L. Solberg, head). An advisory committee has been established to serve as a consulting body and to act as coordinating group for all research on thermophysical properties conducted at Purdue.

### Union Carbide Research Institute

The formation of the Union Carbide Research Institute to engage in basic scientific research has been announced by the Union Carbide and Carbon Corporation. It will be located on the corporation's Westchester property near Tarrytown, N.Y. The institute will be under the administration of Augustus Kinzel, vice president for research.

E. R. Jette, formerly head of the chemistry and metallurgy division at Los Alamos Scientific Laboratory, Los Alamos, N.M., has been appointed director of the institute. His assistants are S. R. Aspinall, formerly with the U.S. Office of Naval Research, and A. J. Stosick, formerly division chief of the rockets and material division of the Jet Propulsion Laboratories at California Institute of Technology.

A major purpose of the new unit will be to study the physical and chemical behavior of matter under ordinary as well as extreme conditions of pressure and temperature. This work will comple-

ment and extend the basic research now being carried on in the existing research laboratories of the Union Carbide and Carbon Corporation. The facilities for the institute are expected to be completed by the spring of 1958.

### Wildlife Refuges

The U.S. Fish and Wildlife Service records show that from 1 Jan. 1953 until 30 June 1956, a total of 162,398 acres has been acquired for wildlife purposes by purchase, lease, donation, or public land order. This figure includes the new Snake Creek National Wildlife Refuge, a 24,623-acre wildlife area on Garrison Reservoir in North Dakota. The Snake Creek Refuge is the largest single addition; Chassahowitzka National Wildlife Refuge in Florida is second with 16,978 acres and Kirwin National Wildlife Refuge in Kansas is third with 10,864 acres.

### Du Pont Education Program

The Du Pont Company will give more than \$1 million in grants to 122 universities and colleges in its program of aid to education for the next academic year. More than half of the entire program is for the improvement of teaching in universities, colleges, and high schools. This phase of Du Pont's program is in three parts.

1) Grants of \$4000 each have been awarded to 70 colleges that have records of strength in undergraduate chemical or technical education. Of each grant, \$2500 is to strengthen the teaching of chemistry and \$1500 is to aid the teaching of other subjects that contribute to the education of scientists and engineers. Grants of \$4000 each go to 23 major universities in order to strengthen the undergraduate teaching of those courses that contribute to scientific and engineering education.

2) An allocation of \$149,000 is for 39 postgraduate teaching assistantships mostly in chemistry, to be shared by 35 universities. The assistantships will go to graduate students who have demonstrated their ability to teach undergraduates in their universities and who will continue teaching during the time they have the grants.

3) A total of \$61,000 in fellowships and scholarships will be used to encourage able young people to become high-school teachers of science and mathematics. This includes 26 fellowships for postgraduate students at seven universities and 20 summer scholarships for undergraduates at two colleges. The company also awarded 98 teachers' fellowships to five institutions for the com-



ing summer to help in-service teachers who are taking summer work for advanced degrees. Awards were made to institutions in which curricula for master's degrees in teaching include substantial emphasis on subject content in science and mathematics.

In addition to its grant to improve teaching, the company will give \$290,000 to universities for fundamental research and \$165,000 for postgraduate fellowships in science and engineering, including grants-in-aid of \$15,000 each to ten universities and \$10,000 each to nine others. There are also summer research grants of \$1500 each to 20 universities. These are to enable younger staff members of university chemistry departments to undertake research of their own during the summer months.

Finally, the company is awarding 43 fellowships for the next academic year, 13 in chemistry, 16 in chemical engineering, six in biochemistry, four in mechanical engineering, and two each in physics and metallurgy. As in previous years, Du Pont is making the awards to the colleges and universities, with the detailed use of the funds left up to them.

### Lafayette's Olin Hall

Lafayette College's new Olin Hall of Engineering Science, built with a \$1,250,000 grant from the Olin Foundation, was dedicated recently. It will house the physics, chemistry, and mathematics departments. The building contains 15 offices for 36 faculty members; two drafting rooms for 90 students; 15 laboratories for 295 students; ten classrooms for 340 students; a chemistry lecture room for 200 students, and a physics lecture room for 100 students.

### Laryngoscope in Music

The laryngoscope has apparently found a useful place in the field of music. William A. C. Zerffi, a voice and speech teacher at the New School for Social Research, has reported that he uses the instrument to determine a singer's voice type.

Voice identification is usually left to the teacher's judgment. But because of bad singing habits or because of the human ability to imitate various sounds, a voice is sometimes misidentified. This can lead to improper training, bad singing habits, or even the shortening of a singer's career. These difficulties can be avoided by using the laryngoscope. The teacher simply looks at the length of the vocal cords. The shorter the cords, the higher the voice; thus a soprano has shorter cords than a contralto, and a tenor has shorter cords than a bass.

### Technical Publication Index

A new *Index of Technical Publications* has been published by the National Advisory Committee for Aeronautics, 1512 H St., NW, Washington 25, D.C. The 222-page volume is the fifth supplement to the basic 1919-49 index.

The new index covers NACA research reports issued from June 1955 through June 1956, and reports published previously but declassified in the same period. The arrangement lists reports in numerical and chronological order of subjects, and includes alphabetical indexes of subjects and authors.

### Aerojet Reactor Training Program

Aerojet-General Nucleonics, San Ramon, Calif., reactor manufacturer, has announced that it is establishing a reactor training program that will be available to industry, colleges and universities, the medical field, and power utilities. The new 1-week course will allow the participant to handle nuclear controls and reactor hardware, such as control rods and fuel elements, in addition to receiving instruction in nuclear reactor theory, operations, and licensing requirements. Students will participate in assembling a reactor and seeing it go critical.

### G.E. Summer Fellowships at Stanford

The General Electric Educational and Charitable Fund for high-school teachers of mathematics, chemistry, or physics will establish a summer fellowship program at Stanford University. Fifty high-school mathematics teachers, to be selected by the university from high-school faculties in 14 western states, will have an opportunity to study new aspects of their subject as well as the application of mathematics to science and industry.

Paul W. Berg of Stanford's mathematics department will direct the program, which will consist of three courses: the first will survey number theory, projective geometry, and other fields bordering on high-school subjects; the second will deal with the fundamental concepts of the calculus; the third will be a seminar on the methods of problem solving. The seminar will attempt to help the teachers in their twofold job of challenging the curiosity of high-school students and developing in them a scientific temper.

In addition to classroom work, the fellows will take field trips to General Electric laboratory and manufacturing facilities in the San Francisco Bay area. Special lectures will be given by mem-

bers of the company's management, scientific, and engineering staffs.

Instruction will begin late in June and last 6 weeks, with the company paying all expenses, including transportation. This is the firm's sixth summer fellowship program and the first in a western university.

### Drop in Shock Therapy

The Veterans Administration reports that electric and insulin shock treatment for mental illness has been reduced by an estimated 90 percent at VA mental hospitals through use of the new tranquilizing drugs. Ivan F. Bennett, chief of psychiatric research in the VA central office at Washington, D.C., made the estimate from a representative sampling of VA neuropsychiatric hospitals throughout the nation.

### Microbiologists Join IGY in Antarctica

The U.S. National Committee for the International Geophysical Year has approved the Society of American Bacteriologists' project for a microbiological survey in Antarctica to be undertaken during 1957-58 in conjunction with the IGY program that is already planned for the region. This is the first officially recognized biological program to be included in this country's IGY plans. The National Committee considers that the project, "while noneophysical in nature, offers the prospect of providing very important and significant scientific information concerning the microbiological aspects of Antarctica."

The SAB participation in the Antarctic program is being formulated by a committee composed of Claude E. ZoBell (chairman), Richard H. McBee, and Frederick D. Sisler. Inquiries should be directed to Dr. Claude E. ZoBell, Scripps Institution of Oceanography, La Jolla, Calif.

### RCA Special Systems Department

The Radio Corporation of America has established a special systems and development department that will be devoted to the planning and development of electronic systems for future military needs. C. B. Jolliffe, vice president and technical director of R.C.A., has been appointed manager of the new department. Other executive posts in the department are as follows: A. W. Vance, chief systems engineer; G. L. Dimmick, chief development engineer; A. C. Gay, manager, projects engineering; and E. W. Pritchard, administrative engineer.

The new department will embrace the systems engineering groups of the David Sarnoff Research Center, the general engineering development section of the defense electronic products organization, and an R.C.A. advanced development engineering group which for more than a decade has concentrated on new electronic techniques and on mechanical and optical devices associated with electronics.

### ONR Mathematics Associateships

Five universities have been selected to participate in a program sponsored by the Office of Naval Research that will provide research associateships in mathematics to postdoctoral candidates. Those taking part are the universities of Cornell, Tulane, Michigan, Washington, and Wisconsin.

### Proposed Legislation

Of the many bills introduced in Congress, some have a special relevance to science and education. A list of such bills introduced recently follows:

S 200. Provide for control and eradication of water hyacinth and certain other aquatic plant growths. Long (D La.), Ellender (D La.) Senate Agriculture and Forestry.

HR 294. Amend Agricultural Act of 1949 and Agricultural Act of 1954 *re* brucellosis eradication program for fiscal year ending 30 June 1958. Laird (R Wis.) House Agriculture.

HR 347. Establish public use of national forest as policy of Congress. Metcalf (D Mont.) House Agriculture.

HR 377. Provide for compulsory inspection by U.S. Department of Agriculture of poultry and poultry products. Polk (D Ohio) House Agriculture.

S 191. Provide for loans to individuals for purpose of enabling them to obtain a college or university education. Langer (R N.D.) Senate Labor and Public Welfare.

S 197. Authorize an emergency 2-year program of federal financial assistance in school construction to states and local communities. McNamara (D Mich.) Senate Labor and Public Welfare.

HR 306. Provide program of grants and scholarships to encourage education and training in field of nursing. Lane (D Mass.) House Interstate and Foreign Commerce.

HR 390. Provide for loans to enable needy and scholastically qualified students to continue post-high-school education. Rodino (D N.J.) House Education and Labor.

HR 397. Encourage expansion of teaching and research in education of

mentally retarded children through grants to institutions of higher learning and to state educational agencies. Rodino (D N.J.) House Education and Labor.

S 201. Authorize comprehensive project for control and progressive eradication of salt-marsh and other injurious mosquitoes in coastal area of southwest Louisiana. Long (D La.), Ellender (D La.) Senate Public Works.

S 230. Amend title VI of Public Health Service Act, as amended, to make certain nonprofit corporations and associations eligible for federal aid under such title. Mundt (R S.D.) Senate Labor and Public Welfare.

HR 366. Amend Federal Food, Drug and Cosmetic Act for protection of public health, by prohibiting new food additives not adequately pretested to establish safe use under conditions of intended use. O'Hara (R Minn.) House Interstate and Foreign Commerce.

HR 383. Provide for establishment of Bureau of Older Persons within Department of Health, Education and Welfare; authorize federal grants to assist in development of operation of studies and projects to help older persons. Rhodes (D Pa.) House Education and Labor.

HR 483. Authorize comprehensive project for control and progressive eradication of salt-marsh and other injurious mosquitoes in coastal area of southwest Louisiana. Thompson (D La.) House Public Works.

HR 373. Establish Commission on the Aging. Ostertag (R N.Y.) House Education and Labor.

HR 307. Provide for establishment of U.S. Foreign Service Academy. Lane (D Mass.) House Foreign Affairs.

HR 491. Provide for appointment of an Assistant Secretary of State for International Cultural Relations. Thompson (D N.J.) House Foreign Affairs.

S 84. Establish Defense Cloud Modification Act of 1957. Case (R S.D.) Senate Armed Services.

HR 453. Amend Veterans' Readjustment Assistance Act of 1952 to provide education and training rights for persons enlisted in armed forces of U.S. during January 1955, but who were not on active duty on 31 Jan. 1955. Smith (D Miss.) House Veterans' Affairs.

S 37. Protect security of U.S. by preventing employment by U.S. of persons found to be disloyal to U.S. Malone (R Nev.) Senate Post Office and Civil Service.

S 195. Amend first section of act entitled "An act to prohibit payment of annuities to officers and employees of U.S. convicted of certain offenses," approved 1 Sept. 1954, to limit its application to cases involving national security. Langer (R N.D.) Senate Post Office and Civil Service.

HR 399. Authorize and direct Civil

Service Commission to make study of classification of and rates of basic compensation payable *re* technical, scientific and engineering positions in classified civil service. Rogers (D Colo.) House Post Office and Civil Service.

S 67. Provide for issuance of special postage stamp in honor of those leaders who pioneered in field of mental health. Carlson (R Kan.) Senate Post Office and Civil Service.

S 68. Provide for issuance of special postage stamp in honor of Dr. Samuel J. Crumrine, who pioneered in field of public health education. Carlson (R Kan.) Senate Post Office and Civil Service.

S 77. Establish Chesapeake and Ohio Canal National Historical Park and provide for administration and maintenance of a parkway in Maryland. Beall (R Md.) Senate Interior and Insular Affairs.

HR 392. Designate building to be constructed as principal office of Atomic Energy Commission under act of 6 May 1955 as Enrico Fermi Building, provide for establishment therein of appropriate memorial to Fermi. Rodino (D N.J.) Atomic Energy.

HR 435. Prohibit discrimination because of race, color, religion, national origin or ancestry. Roosevelt (D Calif.) House Education and Labor.

S 32. Direct Secretary of Interior to convey certain public lands in Nevada to Colorado River Commission of Nevada, acting for Nevada. Malone (R Nev.) Senate Interior and Insular Affairs.

S 258. Establish U.S. Commission on Aging and Aged. Potter (R Mich.) Senate Labor and Public Welfare.

HR 424. Establish Commission on Civil Rights in executive branch of government. Roosevelt (D Calif.) House Judiciary.

S 86. Provide for experimental research program in cloud modification. Case (R S.D.) Senate Interstate and Foreign Commerce.

HR 370. Provide that standard time be measure of time for transaction of business in interstate and foreign commerce. O'Hara (R Minn.) House Interstate and Foreign Commerce.

HR 478. Provide that one floating ocean station be maintained at all times in Gulf of Mexico to provide storm warnings for states bordering on Gulf of Mexico. Thompson (D La.) House Merchant Marine and Fisheries.

HR 481. Authorize comprehensive project for control and progressive eradication of obnoxious aquatic plant growths from navigable waters. Thompson (D La.) House Public Works.

S 7. Provide for establishment and operation of laboratory for study of utilization of soil and water resources of southeastern U.S. Thurmond (D S.C.) Senate Agriculture and Forestry.

S 34. Provide relief for producers of certain critical minerals, metals, and materials indispensable in construction of jet engines. Malone (R Nev.) Senate Interior and Insular Affairs.

S 47. Authorize further extension of certain noncompetitive oil or gas leases issued under Mineral Leasing Act of February 25, 1920, as amended. Anderson (D N.M.) Senate Interior and Insular Affairs.

S 98. Provide for establishment and operation of mining and metallurgical research establishment in Minnesota. Humphrey (D Minn.) Senate Interior and Insular Affairs.

S 151. Provide for civilian atomic power acceleration program. Gore (D Tenn.) Atomic Energy.

S 207. Authorize conveyance to former owners of mineral interests in certain submarginal lands acquired by U.S. in state of North Dakota, South Dakota, Colorado, and Montana. Langer (R N.D.), Young (R N.D.) Senate Agriculture and Forestry.

S 224. Provide for return to former owners of certain lands acquired in connection with Fort Randall Dam project, Oahe Dam project, Gavins Point Dam project, of mineral, oil or gas interests in such lands. Mundt (R S.D.) Senate Interior and Insular Affairs.

S 242. Provide for establishment and operation of a mining and metallurgical research establishment in Maine. Payne (R Maine) Senate Interior and Insular Affairs.

S 268. Provide that Secretary of Army return certain mineral interest in land acquired by him for flood-control purposes. Johnson (D Miss.), Eastland (D Miss.) Senate Public Works.

S 134. Authorize acquisition of certain lands in Mississippi Lake, Ill., in connection with operation of Illinois and Mississippi Canal. Dirksen (R Ill.) Senate Public Works.

S 145. Authorize Secretary of Interior to construct, operate, and maintain a regulating reservoir and other works at Burns Creek site in Upper Snake River Valley, Idaho, Dworshak (R Idaho) Senate Public Works.

HR 350. Provide for federal participation and cooperation with state and local interests in developing water supplies in connection, maintenance, and operation of federal navigation, flood control, or multiple-purpose projects. Natcher (D Ky.) House Public Works.

S 106. Exempt motor vehicles sold for use of religious and nonprofit educational institutions from federal excise tax. Dirksen (R Ill.) Senate Finance.

S 175. Allow additional income tax exemption for dependent child who is full-time college student. Langer (R N.D.), Young (R N.D.) Senate Labor and Public Welfare.

HR 490. Amend Internal Revenue Code of 1954 to provide a 30-percent credit against individual income tax for amounts paid as tuition or fees to certain public and private institutions of higher education. Thompson (D N.J.) House Ways and Means.

## Scientists in the News

FRANCIS D. MURPHY, professor and director of the department of medicine at Marquette University and a member of the faculty for 35 years, has been honored by the establishment at the university of an endowed chair of medicine in his name. A fund of \$350,000 has been established anonymously by a Milwaukee donor.

The income and principal of this endowment is to be spent over a period of 25 years. At present it will pay the salaries of two full-time associate professors. Upon Murphy's retirement, the full-time professor and director of the department will receive his appointment through this endowment as the Francis D. Murphy professor of medicine.

SERGE E. GOLIAN has been appointed head of the reactors branch, Radiation Division, Naval Research Laboratory, Washington, D.C.

THORNTON C. FRY, a mathematician and, until his recent retirement, assistant to the president of the Bell Laboratories, has been appointed senior consultant for Remington Rand Univac, St. Paul, Minn.

R. J. GARBER, who has been director of the U.S. Regional Pasture Research Laboratory at Pennsylvania State University since it was established in 1936, has resigned to accept a professorship at the University of Illinois. In his new post he will serve as a consultant in the north-central region of India, with headquarters at Madhya Bharat College of Agriculture and Research Institute, Gwalior.

Maj. Gen. HARRY O. REICHELDERFER, who retired in 1956 as deputy commanding general of the 4th Army, has been named an assistant vice president in the physical sciences division of the Southwest Research Institute, San Antonio, Tex. His duties will include liaison between the institute and its industrial and military research sponsors, especially in the field of electronics.

ALBERT B. SCOTT, formerly director of product development for Merck and Company (chemical division), has joined the Central Pharmacal Company, Seymour, Ind., as director of research and product development.

DARYLL FORDE, professor of anthropology at the University of London who is visiting the University of California at Berkeley this year, is one of four scholars appointed for the first year of the Phi Beta Kappa visiting scholar lecture program. Forde has recently been engaged in research on social change under urban conditions in tropical Africa. In 1954 he directed a UNESCO conference on this subject and has done extensive field work in West Africa. A former president of the Royal Anthropological Institute, he has been director since 1944 of the International African Institute, founded for the development and coordination of research into African societies and their modern developments.

Forde's particular interests are in societies which have been outside the orbit of the great civilizations and in the impact of modern commerce and industrial development upon their cultures. On his 2- or 3-day visits to universities under the Phi Beta Kappa program, he is lecturing or conducting discussions on many phases of these interests, including the analysis of primitive societies to illustrate the functions and range of complexity of their institutions, as well as the conditions and processes involved in social evolution, and a sketch of the effects of progressive technical advance on the increasing scale and integration of human societies from the Ice Age to the Industrial Revolution. He is also presenting a study of the successive economic changes that have underlain the increasingly rapid social development of West Africa.

Other Phi Beta Kappa visiting scholars are EDWIN G. NOURSE, vice chairman of the Joint Council of Economic Education, a nonprofit organization which assists school systems and teacher-training institutions in improving the quality of social science and economic education, and REUBEN G. GUSTAVSON, president and executive director of Resources for the Future, Inc., a fund established by the Ford Foundation to conduct scientific research in the conservation and wise use and development of natural resources. In his Phi Beta Kappa lectures, Gustavson is discussing the implications for man's future of the tremendous advances that have been made in the physical, biological, and social sciences.

HARDY L. SHIRLEY, dean of the State University College of Forestry at Syracuse University, has been made an honorary member of the Society of Finnish Foresters. He was honored for his "outstanding contributions to the field of international forestry."

MELVILLE EASTHAM has received the Armstrong medal of the Radio Club of America "in recognition of his out-



standing contributions to the art of precision measurements in the radio and electronics field." Eastham founded the General Radio Company, Cambridge, Mass., and now holds the title of honorary president. He was president of the firm from 1915 to 1944 and chief engineer from 1915 to 1950.

WAYNE P. BROBECK, who for the last 10 years has served with the Joint Congressional Committee on Atomic Energy, will join the American Research and Development Corporation as a staff associate. He will make his home in Boston, Mass., the company's headquarters.

CECIL H. ROBINSON, formerly of Glaxo Laboratories, Ltd., Greenford, Middlesex, England, has been appointed chemist in the chemical research department of the Schering Corporation, Bloomfield, N.J.

LYMAN A. BLISS has been appointed president of Union Carbide Nuclear Company, a division of Union Carbide and Carbon Corporation. He succeeds KENNETH RUSH, a vice president of Union Carbide and Carbon Corporation, who will continue to have over-all responsibility for the corporation's nuclear and international activities.

BRUNO H. ZIMM of the General Electric Company Research Laboratories, Schenectady, N.Y., a specialist in polymers, has received the 1957 Leo Hendrik Baekeland award of the American Chemical Society's North Jersey Section. The \$1000 award, which is sponsored by the Bakelite Company, is conferred biennially upon an American chemist under 40 in recognition of accomplishments in pure or industrial chemistry.

ERWIN P. VOLLMER, head, Endocrinology Branch, Naval Medical Research Institute, National Naval Medical Center, Bethesda, Md., has accepted a position as executive secretary of the Endocrinology Panel, Cancer Chemotherapy National Service Center.

HETTY GOLDMAN, an archeologist and the only woman appointed a professor at the Institute for Advanced Study, Princeton, N.J., was honored at a reception on her 75th birthday. J. Robert Oppenheimer, director of the institute, and his wife, were hosts on the occasion. A volume of essays, *The Aegean and the Near East*, dealing with aspects of Dr. Goldman's field, was presented by Oppenheimer. Sponsored by the institute and especially prepared "in honor of one of its early and most distinguished members," the volume contained contributions from about 40 scholars.

JAMES G. HARLOW, associate professor of education at the University of Chicago, has taken a leave of absence to become executive vice president of the Frontiers of Science Foundation of Oklahoma. ROBERT MacVICAR, who had been serving as executive director of the foundation, has returned to his post as dean of the Graduate School of Oklahoma Agricultural and Mechanical College.

K. WARREN EASLEY, analytical chemist and project specialist in the development department of the Monsanto Chemical Company's Inorganic Chemicals Division in St. Louis, Mo., has been appointed development manager of Monsanto's Research and Engineering Division special projects department at Everett, Mass. The special projects department, which is under the direction of H. E. MORRIS, is being established to do research and development work on problems related to national defense and national welfare that complement Monsanto's long-range projects.

LEE CAHN, formerly chief project engineer for Beckman Instruments, Inc., has announced formation of the Cahn Instrument Company in Downey, Calif. The new company will design, manufacture, and sell scientific instruments. Cahn was responsible for the design of the Beckman DK-1 and DK-2 ultraviolet-near infrared automatic recording spectrophotometers, the Beckman 1R2A and 1R4 infrared recording spectrophotometers, the Beckman EASE computer, and a number of other instruments and accessories.

IRVING R. TABERSHAW, since 1953 director of the Division of Industrial Hygiene, New York State Department of Labor, has joined the Nuclear Development Corporation of America, White Plains, N.Y., as director of health and safety. He will be a pioneer in his new role, since N.D.A. is perhaps the first nuclear concern to employ a medical specialist to review both its own operations and its work for clients from the standpoint of health and safety.

Tabershaw will continue as associate professor of occupational medicine in the Columbia University School of Public Health and Administrative Medicine. He has been on the Columbia University faculty since 1946.

O. G. VILLARD, Jr., of Stanford University will receive the Morris Leibmann memorial prize of the Institute of Radio Engineers at its annual convention in New York in March. He is being honored "for his contributions in the field of meteor astronomy and ionosphere physics which led to the solution of outstanding problems in radio propagation."

PETER FREUCHEN, Danish explorer and author, has won the gold medal of the International Benjamin Franklin Society for his "service to mankind in opening new frontiers."

SHIGERU I. HONDA, plant biochemist, recently joined the staff of the U.S. Plant, Soil and Nutrition Laboratory, Agricultural Research Service, Ithaca, N.Y. He is investigating the sulfur metabolism of plants. For the last 3 years he has been associated with R. N. Robertson in the Plant Physiology Unit of the Australian Commonwealth Scientific and Industrial Research Organization and with the Botany School, University of Sydney. He was also a member of the CSIRO Division of Food Preservation and Transport.

WILLIAM G. O'REGAN, formerly director of the statistical analysis department of a food products company in Orlando, Fla., has been appointed mathematical statistician at the California Forest and Range Experiment Station of the U.S. Forest Service. He will be responsible for training the technical staff in statistical methods, advising the staff on design and analysis of research studies, and conducting research on use of statistical methods in forest and range work.

## Recent Deaths

JOHN M. BEAL, Chicago, Ill.; 68; professor emeritus of botany at the University of Chicago; 16 Jan.

RHODA W. BENHAM, Cedarhurst, N.Y.; 61; associate professor of dermatology at the College of Physicians and Surgeons of Columbia University; 18 Jan.

ELEANOR CAROTHERS, Kingman, Kan.; 74; cytologist who had been associated with Kansas University and the University of Pennsylvania; 7 Jan.

WILLIAM R. COX, Clifton, N.J.; 42; chemical engineer for the Seton Leather Company; 18 Jan.

HAYWARD R. HAMRICK, Penn Valley, Pa.; 49; vice president and medical director of Jefferson Hospital; 21 Jan.

GEORGE G. HEYE, New York, N.Y.; 82; founder of the Museum of the American Indian; 20 Jan.

ROBERT W. KEETON, Chicago, Ill.; 73; former head of the department of medicine at the University of Illinois College of Medicine; 22 Jan.

HERBERT S. LEWIN, Bronx, N.Y.; 49; supervising psychologist since 1948 at the New York regional office of the Veterans Administration; 23 Jan.

OSCAR L. POLK, Forest Hills, N.Y.; 58; chemical engineer with the Curtiss-Wright Corporation; 18 Jan.



# Reports

## Effect of Reserpine and Chlorpromazine on Sarcoma 37

It has been shown (1) that, when reserpine is administered to mice that are carrying the lymphoid tumor L1210, the mice become deeply depressed and remain so for 6 to 8 days. During this period they neither eat nor drink. Under these conditions, the local tumor frequently regresses and survival time is significantly increased.

Because of the unusual aspects of the response of this lymphoid tumor to reserpine, it was of interest to determine how a solid tumor, such as sarcoma 37, would respond following administration of reserpine.

Twenty-five CAF<sub>1</sub> hybrid mice, carrying 6-day-old intramuscular implants of sarcoma 37, were given doses of reserpine subcutaneously (50 mg/kg of body weight). A similar group served as untreated controls. During the course of an hour or more, the animals that received the drug became deeply tranquilized and remained so for 5 to 6 days, by which time practically all were dead, presumably from inanition and dehydration, and perhaps from some specific effect of the drug itself.

During their depressed state, the mice kept their eyes closed and burrowed their heads in the shavings. In addition, a lowering of body temperature was observed; the mice were decidedly cool to the touch, and their urine, voided when they were handled, felt cold. Rectal temperatures were below 94°F (the lowest calibration of the thermometers used), whereas the rectal temperatures of mice bearing 6-day intramuscular implants averaged 97°F, and the temperatures of normal, nontumor-bearing mice averaged 100°F. All treated mice lost considerable

weight, as was determined by making carcass measurements at death.

On the day the drug was injected, and every third day until the end of the experiment, the tumors were measured with calipers along their three diameters. The average of these measurements was used to determine the volume of the tumor, calculated as a sphere.

As can be seen from a typical experiment shown in Table 1, tumor growth in the animals that were treated with reserpine ceased at once. The tumors in untreated animals continued to grow at a normal rate, so that at the end of 6 days their average volume was more than 3 times that of the tumors in the treated mice.

To determine whether this effect was limited to some specific action of reserpine, or was merely a consequence of a prolonged state of depression regardless of how induced, other depressant drugs presumably acting by a different mechanism were tested—for example, phenobarbital, urethane, chloral hydrate, Dori-den, and chlorpromazine.

Chlorpromazine placed the animals into a deeply tranquil state comparable to that following the administration of reserpine. In Table 1 are given the results of a typical experiment in which, at the end of 5 days, the tumors in the untreated animals were also about 3 times the volume of those borne by treated mice.

To ascertain whether any direct cellular effect of these two drugs contrib-

uted to the marked inhibition of tumor growth, mice tranquilized by each drug were sacrificed at the end of 6 days, and sections of the tumors were fixed in Zenker-formol and stained with hematoxylin and eosin.

Although it is difficult, because of spontaneous necrosis, to assess damage in advanced tumors (12 days old) a distinct impression was obtained that more histologic damage occurred in the treated than in the control groups. As a further check, mice with 6-day tumors were given reserpine or chlorpromazine and sacrificed 3 days later. Again the impression was that damage in the treated tumors was more extensive than in the controls.

Sarcoma 37 grown as an ascites tumor was also used. Groups of mice carrying 3-day-old ascites tumors were given doses of reserpine or chlorpromazine intraperitoneally to maintain tranquillity for several days. Other mice served as untreated controls. Every day for 4 days, samples of ascitic cells were drawn from all three groups and examined in the fresh state and also as smears which were fixed by air-drying and immersion in methanol and then staining with Giemsa.

Except for an increase in size and number of cytoplasmic vacuoles, the Giemsa preparations from both treated groups showed no cytotoxic effects. Cells in all stages of mitosis were evident.

Beginning at 48 hours after treatment, fresh smears from mice of both reserpine- and chlorpromazine-treated groups showed a progressive increase in the number and size of yellowish, refringent granules (seen as vacuoles in the alcohol-treated Giemsa smears). These stained deeply with Oil-Red-O, indicating the presence of neutral fat. Negative results with periodic acid-Schiff treatment indicated they were not polysaccharide. Cells from untreated mice did not exhibit such granules (2).

The induction of a deeply tranquilized state by reserpine and chlorpromazine was accompanied by an immediate ces-

Table 1. Effect of reserpine (3) and chlorpromazine (4) on growth of sarcoma 37 in CAF<sub>1</sub> mice. The drugs were administered in the vehicle provided with each. Neither vehicle had any effect on the growth of sarcoma 37. The figures in parentheses indicate the number of surviving mice.

Treatment	Dose (mg/kg)	Average tumor volume (mm <sup>3</sup> )		
		Day treatment was begun	3 days	5-6 days*
Reserpine	50	1262 (25)	1129 (22)	1118 (11)
Controls (untreated)		1080 (25)	2413 (25)	3797 (25)
Chlorpromazine	50†	921 (28)	944 (26)	1040 (8)
Chlorpromazine	25†	899 (25)	876 (25)	854 (5)
Controls (untreated)		992 (25)	1899 (25)	2739 (25)

\* The experiments with reserpine were terminated 6 days after the first treatment, those with chlorpromazine 5 days after treatment.

† A supplementary dose of 25 mg/kg was given 2 days after the first dose.

All technical papers and comments on them are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table or one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in *Science* 125, 16 (4 Jan. 1957).

sation of the growth of sarcoma 37. This phenomenon is striking; whether or not the concomitant tumor necrosis was the result of a specific action of the drugs used cannot now be answered. The effects noted may also be explained as the result of the prolonged depressed state with accompanying inanition, dehydration, changes in metabolism, lowering of body temperature, and a drop in blood pressure with consequent hypoxia. All these are factors which by themselves can produce marked tumor damage and can slow tumor growth.

The appearance of fat granules in the ascitic cells similarly may be the result of the depressed state of the host. Unlike the controls in which the ascites daily increased in volume, the ascitic fluid in treated mice was very scanty, thick and viscous, but rich in cells. As a result of the progressive dehydration and other changes, the metabolic state of the ascitic cells could well have been affected, and the fat granules (which many would call "degeneration" granules) could be the consequence of the changes.

Whether the action of these drugs is specific or is mediated through the host, it is suggested that these drugs provide an additional means for study of the host-tumor relationship, particularly in conjunction with other tumor-necrotizing drugs.

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#### References and Notes

1. A. Goldin *et al.*, *Science* 125, 156 (1957).
2. We wish to thank Ira Kline for preparation of the material that was treated with the special stains used in this investigation.
3. Serpasil (Ciba).
4. Thorazine (Smith, Kline and French).

26 November 1957

### Effect of Gibberellic Acid on Growth of Maize Roots

Gibberellic acid has been shown to stimulate markedly stem and leaf elongation in a number of plants (1-4). The specific genetic constitution of a strain or variety appears to determine whether or not it will respond to applied gibberellic acid by increased shoot growth. So far the most notable responses have been observed in dwarf types. Phinney (2) has reported that applications of gibberellic acid to five single-gene, dwarf mutants in maize so enhanced growth that the treated plants were almost indistinguishable from plants carrying the normal alleles of the mutant genes. One other dwarf mutant made only a slight response, and another made no response. Such differential responses of shoot

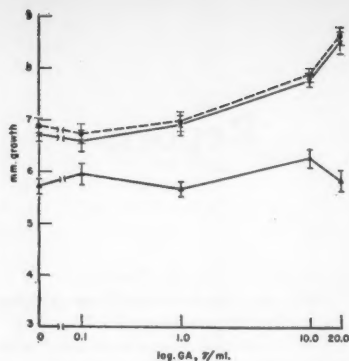


Fig. 1. Growth of excised, apical, 10-mm segments of primary roots of two maize inbreds and their hybrid as affected by gibberellic acid. The limits indicated at each graph point represent  $\pm 2$  times the standard error;  $\times$ , hybrid;  $\bullet$ , line 854,  $\blacktriangle$ , line 857.

growth have also been reported in varieties of *Pisum*, *Phaseolus*, and *Vicia* containing dwarfism alleles (1). To date, the only experiments on root growth reported are those of Brian, Hemming, and Radley (3), who found that gibberellic acid had no significant effect on the growth of roots of cress seedlings.

In the work reported here, gibberellic acid (5) was added to White's supplemented solution (6) in which excised, apical, 10-mm segments of maize roots were grown for the 24-hour period representing the sixth to seventh day after the beginning of germination. Apical segments of both primary and adventitious seminal roots of two inbred lines of maize and their distinctly heterotic hybrid, bearing our laboratory numbers 854, 857, and  $854 \times 857$ , were used. Neither inbred line contains any dwarfism alleles, and other studies have shown that the growth rates of the inbreds beyond the very early seedling stage are comparable to the growth rate of the hybrid. The effects of gibberellic acid on growth of excised apical segments of primary roots are shown in Fig. 1. The points on the graph for 0.1, 1.0, and 10.0  $\mu\text{g/ml}$  represent means of three or four replicates of at least ten roots each. The smallest number of roots represented is 35, the largest 93. The points for 20.0  $\mu\text{g/ml}$  represent only single tests with 16 to 40 roots. The supply of gibberellic acid was too limited to permit repetition of the 20  $\mu\text{g/ml}$  tests. The primary roots of line 857 were not affected by gibberellic acid over the range of concentrations used. Those of line 854 were significantly stimulated by concentrations of 10  $\mu\text{g/ml}$  and further stimulated by 20  $\mu\text{g/ml}$ . At 20  $\mu\text{g/ml}$ , growth was increased on the order of 24 percent. The effect on the primary roots of the hybrid appears to be identical with that upon the roots of 854. The curves

suggest that the primary roots of 854 and the hybrid might be further stimulated by higher concentrations.

The growth of the adventitious seminal roots was affected by gibberellic acid in the same manner as the growth of the primary roots, but the amount of stimulation of 854 and the hybrid was proportionately less than that in the primary roots, about 12 percent at 20  $\mu\text{g/ml}$ . The adventitious seminal roots are of later origin than the primary roots, and they normally grow somewhat less than the primary roots under the conditions and during the experimental period used here.

More extensive experiments with the effects of gibberellic acid have been carried out (7), and it may be noted that all our results indicate that the root growth in certain genotypes of maize is significantly stimulated by gibberellic acid. The results presented in this preliminary note, showing a positive growth response of one inbred, no response by the other inbred, and a hybrid response essentially parallel to that of the first inbred, suggest direct inheritance of a growth system which can be affected by gibberellic acid.

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JOYCE KEPHART

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Clayton Foundation for Research

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5 November 1956

### Radiocarbon Dates from Sandia Cave, Correction

Frank C. Hibben has reported in *Science* (1) that in 1948 the late Kirk Bryan submitted two samples of charcoal from Sandia Cave for radiocarbon age determination to W. F. Libby, who was then at the University of Chicago. Hibben reported that these samples came from fire hearths located in the Sandia level of the cave and that "From these two samples, tentative dates of 17,000-plus years ago and 20,000-plus years ago, respectively, were derived." There is no proof that these alleged dates were ever determined by radiocarbon analysis or that Bryan ever submitted any samples from Sandia Cave to any laboratory.

It is a matter of record that the dates were not determined at the University of Chicago laboratory, as Hibben, in correspondence, has recognized. No other laboratory is known to have determined radiocarbon dates until the Lamont laboratory began operations in 1951. Bryan died on 22 August 1950.

None of Bryan's intimate associates, including reputable archeologists and geologists, some of whom were deeply concerned with the development of radiocarbon dating, can recall having heard Bryan mention the samples or the dates to which Hibben refers. Furthermore, Bryan's records have been searched and no reference to the alleged Sandia samples has been found. The dates must be struck from the record before they cause further confusion.

Other confusing evidence indicates that the dates lack a proper source and record. Hugo Gross quotes "Dr. Frank C. Hibben, oral communication," as the authority for the statement that "... this method (radiocarbon dating) recently indicated an age of 11,000 and 19,000 years, respectively, for the Folsom and Sandia layers in Sandia Cave" (2). These dates, published in 1951, differ significantly from those published by Hibben in 1955—that is, 17,000-plus and 20,000-plus years ago. The latter dates were alleged to have been determined on charcoal said to have come from two fire hearths of only the Sandia level. The discrepancies in figures and the attribution to levels throw great doubt upon the statements in Hibben's article in *Science*.

The repudiation of the dates quoted by Hibben as originating with Bryan has no bearing on the dates from Sandia Cave determined by H. R. Crane (3). Such dates indicate the radiocarbon content of the samples delivered to the Michigan laboratory. Whether or not these samples are contemporaneous with the Sandia level is a completely different, unrelated question.

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8 November 1956

In regard to the two samples of charcoal from Sandia Cave collected by the late Kirk Bryan, there has been a dearth of evidence as to where and how Bryan dated these samples. I am in agreement with Johnson that these dates should be removed from the record. This removal, of course, in no way invalidates either the very fine geologic work of Bryan or the dating of the Sandia deposits themselves.

The dates referred to by Hugo Gross were extracted from a series of lectures one of which was given by me at the University of Erlangen, Germany. These dates were derived from Bryan's geologic work and were extremely tentative. Dating by geologic means and carbon-14 were undoubtedly confused. Gross is in error in his dates of 11,000 and 19,000 years, respectively, for the Folsom and Sandia layers of Sandia Cave. The original dates given in the Erlangen lecture were 11,000 B.C. for a Yuma site, 9000 B.C. for Folsom layers in Sandia Cave, and 17,000 B.C. for Sandia level in Sandia Cave. All these dates were derived by stratigraphy and not by the radiocarbon method. As yet no carbon-14 date has been derived from the Folsom level of Sandia Cave.

Removal from the record of the radiocarbon dates attributed to Bryan does not invalidate the dates determined by H. C. Crane from mammoth ivory from Sandia Cave. These are substantiated by other evidence.

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26 December 1956

### Theory of Ice Ages

The theory of glacial and interglacial periods during the Pleistocene offered by Ewing and Donn in a recent issue of *Science* (1) is very provoking. It is certainly true that the melting of an Arctic Ocean ice sheet such as exists at present would, by making the Arctic Ocean ice-free, provide an increased source of moisture for the polar atmosphere, and it is true that this could have been accomplished through a greater interchange of water between the Atlantic and Arctic oceans. Whether this greater interchange would be associated with a cooling of the Atlantic, as the authors maintain, and also whether the open Arctic Ocean with its new moisture supply would favor the growth of glaciers over the areas to the south, is, however, a matter for further consideration.

While all the evidence as far back as the 1930's points to a warming of the Arctic Ocean, the more recent evidence shows a simultaneous though less marked warming of the Atlantic as well (2). Equally, the extensive deglaciation that has occurred within the past 50 years or so, particularly in the 1930's, coincided with a sharp decrease in the thickness of the Arctic ice pack from a value of approximately 3.6 m, which was measured by the Fram expedition, to a value of only 2 m, which was obtained by the North Pole expedition in 1937 and also coincides with a shrinkage of its area

by more than 10 percent from the earlier to the more recent period. Consequently, if the process were to continue, an open Arctic Ocean would be associated with increasing deglaciation and eventually with no ice whatsoever.

It is acknowledged that a very substantial lowering of sea level would, by restricting the interchange of water between the Arctic and Atlantic oceans, make it possible for the Arctic Ocean to freeze over. However, a frozen Arctic Ocean would, according to the authors' view, only stop the glaciation from growing through the cutting off of the new moisture supply. For a waning of the glaciation itself, to make the cycle complete, the authors assume a starvation of the ice. This might be true of the inland ice in a very limited measure, but not of the glaciers whose waning is accompanied by a recession.

Rather, I think that the same agency that is responsible for the simultaneous warming of the Arctic and Atlantic oceans and for the shrinkage of the arctic ice pack is also responsible for the deglaciation, and that this is due primarily to a rise in temperature. In accepting the authors' claim that an open Arctic Ocean provides a new supply of moisture for the polar atmosphere and for an increase in precipitation, I suggest that this precipitation is in the form of rain, not only over the adjacent lands to the south, but also over the Arctic Ocean.

The fact that within the recent period the temperature of the South Atlantic Ocean has also increased suggests that the agency responsible operated on a broad scale and from outside the earth.

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2. J. Smed, *Cons. perm. intern. Explor. Mer. Rapp. proc. Verb.* 125, 21 (1949); I. I. Schell, *J. Cons. perm. intern. Explor. Mer.* 18, 1 (1952); H. J. Bullig, *Deut. Wetterd., Seewetteramt.* No. 5, 1 (1954); H. Riehl, "Sea-surface temperatures of the North Atlantic, 1887-1936" (Dept. of Meteorology, Univ. of Chicago, 1956).

10 October 1956

### Presence of Serotonin in Lung and Its Implication in the Anaphylactic Reaction

Serotonin (5-hydroxytryptamine) is known to be widely distributed in the animal and plant kingdoms. In animals it has been reported to be present in gastrointestinal tract, blood platelets, spleen, and brain (1, 2), and possible functions for serotonin in each of these tissues have been suggested. There has been speculation for some time whether serotonin may



Table 1. Serotonin and monoamine oxidase in lung. The figures for serotonin content represent the average values obtained in several animal experiments, and those in parentheses give the number of animals used. The figures for monoamine oxidase activity represent the average values obtained on two or more animals.

Species	Serotonin content ( $\mu\text{g/g}$ )	Monoamine oxidase activity ( $\mu\text{g}$ destroyed/g hr)
Mouse	1.9 (12)	960
Rat	2.3 (9)	960
Rabbit	2.1 (11)	1200
Guinea pig	0.2 (10)	1800

be responsible for some of the manifestations of the anaphylactic reaction. Humphries and Jaques (3) demonstrated that addition of purified antigen and antibody to normal rabbit platelets suspended in plasma released both serotonin and histamine from the platelets. Herzheimer (4) reported a relationship between tolerance to serotonin and desensitization in the guinea pig. Waalkes *et al.* (5) have recently shown that serotonin, as well as histamine, is released in rabbit blood (*in vitro* and *in vivo*) during anaphylactic shock.

Since serotonin is a potent bronchoconstrictor (6), the studies reported here were undertaken to determine whether it may play a part in the pulmonary aspects of anaphylaxis.

The serotonin content of lung homogenates was determined spectrophotofluorometrically (2). 5-Hydroxytryptophan (5HTP) decarboxylase activity was measured by the procedure of Clark *et al.* (7), and monoamine oxidase activity was measured by the procedure described by Sjoerdsma *et al.* (8).

Serotonin was found in relatively high concentration in lung. The amounts present in lung of several animal species are shown in Table 1. Not only was serotonin itself found to be present in lung, but also the enzymes which make it (5-hydroxytryptophan decarboxylase) and destroy it (monoamine oxidase). The latter was found to be present in high concentration (Table 1). The decarboxylase activity was relatively weak, less than  $15 \mu\text{g}$  of 5-hydroxytryptophan being converted to serotonin per gram of lung, per hour, in any of the species investigated.

It is of interest that guinea pig lung contains little if any serotonin, whereas mouse lung contains relatively large amounts. It is known that mouse lung contains little histamine, whereas the histamine content of guinea pig lung is relatively high (9). These findings may ex-

plain some interesting observations that have been made in the past. Thus, in guinea pigs, the pulmonary aspects of anaphylactic shock appear to be completely explained on the basis of histamine release, and antihistaminic agents can block the effects almost completely (10). On the other hand, antihistaminic agents have little influence on anaphylactic shock in the mouse (11). Lysergic acid diethylamide, an inhibitor of the actions of serotonin on smooth muscle, has been reported to protect against an anaphylactic-type response (12). In rats and rabbits and in other species in which both serotonin and histamine are present in lung, both agents should be considered in explaining the pulmonary effects seen in anaphylaxis.

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14 November 1956

#### First Discovery of Marine Wood-Boring Copepods

Marine wood borers are known to occur in the following animal groups: Pelecypoda (for example, *Teredo*, *Bankia*, and *Martesia*) and the crustacean orders Isopoda (for example, *Limnoria*) and Amphipoda (for example, *Chelura*) (1). The wood-boring habit has not been previously reported for the crustacean order Copepoda; however, Bocquet (2) recently described an algal-boring harpacticoid copepod, *Diarthrodites feldmanni*, from France.

While studying the biology of marine wood borers (3), we discovered several species of copepods that had wood material in their digestive tracts. These copepods were found in culture dishes in

which populations of *Chelura terebrans* Philippi had been maintained but had died. Despite cleaning of the dishes, new woody fecal matter continued to be deposited and copepods were found browsing on the surface of the wood in a manner similar to that of *Chelura terebrans* (4).

Individual copepods were isolated and reared through several generations in petri dishes that were supplied only with sea water and chips of Douglas fir. Fecal matter similar in composition to that of *Chelura terebrans* (4) was produced by the copepods. Unlike the active borers *Teredo* and *Limnoria*, the copepods made no discrete holes.

Five species of wood-boring harpacticoid copepods belonging to the genera *Tisbe*, *Amphiascus*, and an unknown genus were isolated from test blocks collected in Los Angeles and Long Beach harbors, California (5).

Wood blocks were suspended at ten stations in Los Angeles and Long Beach harbors for 28-day intervals from November 1955 to November 1956. Copepods were observed throughout the year at many of the stations. However, the greater number of specimens was taken during the winter months. This may be the result of lower water temperatures, generally higher amounts of dissolved oxygen, and lesser quantities of fouling organisms settling on the blocks. It is possible that the copepods need certain amounts of debris or fouling organisms for protection. Test blocks that were grooved prior to use contained a greater number of specimens than smooth blocks; this was similar to what was observed with *Chelura* (4). Correlation with temperature and dissolved oxygen in Los Angeles and Long Beach harbors showed that the animals were present on the test blocks when the sea water temperature ranged from  $15^{\circ}$  to  $20^{\circ}\text{C}$  and when the dissolved oxygen content of the water was above 1.1 ppm. The animals did not occur on the wood blocks when the dissolved oxygen was lower than 1.1 ppm at the time of collection.

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4. J. L. Barnard, in *Essays in the Natural Sciences in Honor of Captain Allan Hancock* (Univ. of Southern California Press, Los Angeles, 1955), p. 87.
5. A report on the systematics and the biology of these copepods is in preparation.

10 December 1956



## Book Reviews

**Protozoologie.** Karl G. Grell. Springer, Berlin, 1956. 284 pp. Illus. DM. 59.

In many ways, this is a refreshing treatment of the field of protozoology. Karl Grell has drawn heavily on his own investigations and on modern discoveries of protozoologists, particularly in the United States where he recently spent several months. One result has been that much of the content is new in the sense that it has never appeared previously in book form. The drawings and photographs are particularly attractive; the author has relied heavily on good photographs, and the publisher has apparently spared no expense in insuring the best possible reproduction for the illustrations.

Grell's concept of the Protozoa and his taxonomic treatment of some of the major groups will probably not be acceptable to all protozoologists. I was pleased to note Grell's forthright acceptance of the Protozoa as *unicellular* animals, thereby avoiding the semantic pitfall of those who discuss *cellular* morphology or *cellular* physiology in Protozoa, organisms which they have described previously as being either *acellular* or *noncellular*. The author's exclusion of the entire group of the Cnidosporidia from the Protozoa on the basis of a differentiation among the somatic cells and nuclei, a character absent by his definition from other Protozoa, will strike many protozoologists as being somewhat arbitrary, especially in the absence of any elaboration of the statement that they are perhaps degenerate Metazoa.

The classification of the Opalinida as an order of the Flagellata, and of the Hypermastigidae as a family of the Polymastigina might be considered by some to be debatable on the basis of present evidence. The transfer of the Haemosporidia from a separate order to a family Haemosporidae of the Coccidia, on the other hand, is a change which has seemed inevitable following the discovery of the exo-erythrocytic phases of Plasmodium. The formation of a new suborder Eucoccidia to accommodate a single species of sporozoan without schizogony, and the creation of a second new suborder, the Schizococcidia, to accom-

modate the rest of the Coccidia seems rather drastic, inasmuch as the species in question has gregarine as well as coccidian characteristics.

Grell has the facility of writing simply and of explaining with great clarity. The sections on asexual reproduction, and on fertilization and sexuality are particularly well written. Not all protozoologists in this country are convinced, however, of the existence of sexual processes in a single representative of the Amoebozoa, *Sappinia diploidea*.

It is to be hoped that protozoologists will some day come to an agreement with respect to the meaning of the term *blepharoplast*. It is used here (pp. 16, 203) as synonymous with the *kinetoplast* as defined by Kirby. Other workers equate it with the basal granule.

A few minor points might be corrected in future editions. The experiments of Taylor would contradict the statement that there is no experimental proof that the longitudinal fibrils of ciliates conduct stimuli (p. 171). On the other hand, there is no published support for the view that the lens of a dinoflagellate "eye" actually concentrates light rays (p. 174). There is considerable recent evidence that the ciliates in ruminants may perform some essential functions for the host, so that they should not properly be described as commensals (p. 187). There is little reason to continue to call the rod-shaped structures of *Lambia* (Giardia) parabasal bodies (p. 206), for they show practically no correspondence with parabasals in other flagellates. The name *Plasmodium praecox* (p. 253) is a synonym of *P. relictum*. The method of *Balantidium coli* in attacking the intestine of man is commonly due to the action of the parasite itself rather than to toxic or bacterial injury (p. 265).

The intimate knowledge of the author in certain fields of protozoology has produced a marked unevenness in the topics treated. For example, of the 187 pages set aside for the general treatment of the Protozoa, 140 pages are devoted to the nucleus, asexual and sexual reproduction, and genetics. The result is often a very detailed and highly technical discussion of such topics as chromosome structure and behavior, or of modifications of types

of mitosis found in the Hypermastigidae of the gut of the wood roach, while the vacuolar system of the Protozoa, for example, is covered in four paragraphs. Modern studies of protozoan nutrition, furthermore, are practically never mentioned, the role of *Tetrahymena* in this field being referred to in a short paragraph in small type. The phenomena of encystment, of excystment, and of regeneration are hardly mentioned.

Similarly in the treatment of the different groups of the Protozoa, while there are some very beautiful photographs and a highly technical discussion of reproduction among the Foraminifera, covering 12 pages, the ciliate suborders Apotomea and Thigomotricha are dismissed in two and one-half lines.

In a future edition, the addition of a subtitle defining the limited scope of the book would be more accurate than the term *Protozoologie*. Within the bounds he has set for himself, Grell has done an excellent job in presenting in a clear and attractive manner certain aspects of modern protozoology. The listing of recent films dealing with the Protozoa is a welcome innovation.

GORDON H. BALL

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**Physics, Psychology and Medicine.** A methodological essay. J. H. Woodger. Cambridge University Press, London, 1956. 146 pp. \$1.75.

J. H. Woodger believes that in the education of British physicians excessive emphasis has been placed on the approach to problems which regards physics as the fundamental discipline. In consequence, graduates of medical schools are not adequately equipped to handle the increasing number of cases of mental illness that they will encounter in their practice. The ostensible aim of this little book is to show the need for a medical training which will recognize the importance of psychology and even of relevant parts of the social sciences.

Most of the book, however, is an elementary account of scientific methodology; and, except for occasional asides, it deals largely with logical and epistemological distinctions that are the stock in trade of beginning courses in these subjects. Woodger explains at some length the differences between statements that are first-person reports of observations (not very convincingly described as statements concerning "feelings in a very wide sense of the word"), generalizations of such statements, and explanatory hypotheses. He notes that the connections of the latter to observation statements are rather loose, and that there is

no way of knowing whether explanatory hypotheses are true; and he maintains, in somewhat misleading language, that an element of "faith" is involved in reaching such hypotheses. The purpose of this long detour into methodology seems to be to make the reader more tolerant of the distinctive approach of medical psychology and to provide a foundation for the thesis that many sciences are "autonomous" in relation to physics. But to me, the detour appears to be quite irrelevant as an intellectual support for the educational plea Woodger is ostensibly making.

Woodger takes to task the proposal to employ a purely behavioristic language and method in the treatment of mental illness, on the ground that such an approach does not work with many patients. Woodger may be quite right in this. However, he also goes on to say that, since such an approach has "more remote political and theological implications," and since "medicine should be neutral in these matters and offer its helping hand to all and sundry, irrespective of creed or politics," medicine "must be shy of adopting any doctrine which will restrict its hypothesis-making and modes of treatment to one particular theoretical direction" (p. 143). But what Woodger is apparently recommending here is that in *constructing* explanatory hypotheses in medical psychology, one ought to keep a weather-eye open to the political and theological convictions of patients. In my opinion, this is the path to madness.

ERNEST NAGEL

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**Glaucoma.** Transactions of the first conference, 5-7 Dec. 1955, Princeton, N.J. Frank W. Newell, Ed. Josiah Macy, Jr., Foundation, New York, 1956. 251 pp. Illus. \$4.50.

This volume is a record of accepted facts, experiences, animal experiments, opinions, and theories on glaucoma and factors that influence intraocular pressure. It contains the papers that were presented at a conference by a panel of investigators predominantly from the ophthalmic field.

The first of three principal sections is concerned with a type of the disease termed "angle closure glaucoma." This type of glaucoma is the most satisfactorily treated but also is of lowest incidence. Unanimity of opinion is expressed concerning this type of the classified disease, both with regard to mechanism of the cause and the control. The theory of pupillary block, now more generally accepted by ophthalmologists, is unanimously agreed upon by the panel.

The second section is concerned with factors which influence the intraocular pressure that originates in the central nervous system. Experiments previously published by Von Sollman (National Institutes of Health) are reviewed and discussed. These experiments demonstrate changes in the intraocular pressure in response to an electric stimulation on an isolated area of the interbrain of the cat. No conclusions were offered that suggest a relationship of these experiments to glaucoma. The effect of such stimulation was dramatic but not sustained.

Opinions varied concerning the existence of afferent or efferent nerve end organs located in the trabecular meshwork of the anterior chamber. No conclusions were reached on whether nerve fibers in the area merely pass through this tissue or have terminations in this location. Certain chemical experiments were cited as evidence of the existence of an efferent function from one eye to the other. Interpretations of the results were sharply questioned by several members of the panel.

The third and largest section is concerned with the anatomical location of the resistance to the outflow of aqueous fluid from the anterior chamber. Barany (Sweden) reviews his experiments on enucleated eyes. The eyes were perfused with aqueous fluid, and a level of resistance to the standard condition of the experiment was more or less constant. Hyaluronidase was added to the perfusion fluid; this caused the resistance to outflow to drop by approximately one-half. It is Barany's assumption that the hyaluronidase dissolves some of the mucopolysaccharide of the anterior chamber trabecular structure, thus allowing for an increased flow of aqueous fluid. Operative destruction of the trabecular meshwork reduces the resistance to aqueous outflow to zero. From these experiments it would appear that the structure responsible for the increased or decreased resistance to aqueous outflow is located in the trabecular meshwork.

Grant (Boston) did the same operative destruction of the trabecular meshwork that Barany did and found in the majority of instances that there was no increase in the facility of aqueous outflow. Grant concluded that the obstruction to outflow was more peripheral than it is in the trabecular meshwork. Considerable discussion and questioning by the members of the panel failed to throw light on the discrepancy in results.

Barany further describes perfusion experiments in an attempt to locate the sensitive material located in the angle, which he assumed to be hyaluronic acid. Experiments designed to throw light on the regulation of resistance of the angle suggested that the angle was able to adapt to the absence of hyaluronic acid; other

parts of the meshwork increased their resistance to outflow.

Becker (St. Louis) presents results of tonography after the use of Diamox to study further the pressure regulatory mechanism by altering the change in inflow without altering the resistance to outflow.

There is considerable discussion on cellular volume in the angle and the possibility of its influence on outflow.

Autobiographical sketches of the participants are appended. The index is excellent.

L. CONNER MOSS

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**Advances in Carbohydrate Chemistry.** vol. 11. Melville L. Wolfrom and R. Stuart Tipson, Eds. Academic Press, New York, 1956. xviii + 465. \$11.

I make no claim to being a qualified judge of detailed presentations by recognized experts in eight highly specialized carbohydrate fields. However, to one with at least a working knowledge of carbohydrate literature and a daily need for its effective application, these *Advances* have proved their value. The very high editorial and technical standards, established by the previous ten volumes, have been rigorously maintained.

Continued application of periodate oxidation in establishing carbohydrate structures justified a concentrated study (by J. M. Bobbitt). Since this technique can be misapplied all too easily by inexperienced hands, a particularly valuable section stresses significant precautions to be observed during its use.

The multiple functionalities of the osones and of kojic acid have attracted much attention with very little interest in applications having developed. Although osones are usually represented in the  $\alpha$ -ketoaldehyde manner originally proposed by Emil Fischer, the consistent lack of ketonic properties makes this open-chain structure very questionable. A survey of osone research, supplied by S. Bayne and J. A. Fewster, should assist in stimulating further studies. Much more attention has been given to kojic acid, even to the extent of several past attempts and at least one current attempt at commercialization, and A. Beélik has written a very worth-while chapter. Despite its structural challenge, significant industrial applications are still in the future.

F. G. Gonzáles presents an interesting discussion of the products from reactions between reducing sugars and  $\beta$ -ketonic esters along with detailed procedures and tables of constants. The author is obviously intrigued by the possible unique biological significance of these com-

pounds and the information assembled indicates that further research is justified.

Any student or research investigator with an assignment in the area of biosynthesis of simple sugars soon becomes aware that the existing literature is bewilderingly complex. As is shown by L. Hough and J. K. N. Jones, the biosynthetic reaction sequences may very well be quite diverse. Their excellent critical examination of the field is certainly welcome.

Branched chain sugars were very rare when volume 1 of these *Advances* appeared; even now nomenclature has not been organized. Fortunately, F. Shafizadeh has collected the existing information and has proposed a reasonable system for deriving names. Since numerous branched sugars of biosynthetic origin have been described in recent years, this step was well taken. The nucleic acids represent a radically different situation. More than sufficient information existed to permit a survey for volume 1, and the tremendous literature growth since is ample justification for a new study. G. R. Barker gives special emphasis to synthesis, isolation, and fine structure examinations in a chapter on these "acids."

Earlier volumes have presented several phases of polysaccharide chemistry, but relatively recent physical-chemical studies have greatly expanded the general understanding of starch; this has been compiled for volume 11 by C. T. Greenwood. Although there is still incomplete agreement on such characteristics as molecular weights, relative modes of attack by acids, alkalies, and enzymes on amylose and amylopectin and the binding of iodine in helices, the quantity and quality of current investigations are encouraging.

The editors are to be congratulated for having produced another excellent volume in this valuable series of *Advances*.

HARRY GEHMAN

Corn Products Refining Company

**Features of Evolution in the Flowering Plants.** Ronald Good. Longmans, Green, London-New York, 1956. 405 pp. Illus. \$6.

"Whatever opinion may be held about the idea of evolution itself, or about its possible modes of operation, it cannot be denied that change with time is an all-pervading principle of the natural world" (p. v). With these words Ronald Good, of the University of Hull, begins a curious but interesting book on the evolution of the flowering plants. He feels that "Many particular problems require to be thought out again from the beginning, but the special need is for a new, objective, and sober consideration of the

facts, and, above all, of the facts in some of those aspects of biology which have so far received less attention, and which are therefore less obscured by the patina of controversy" (p. v). Again, letting Good speak for himself, we find that he believes that "... when these neglected facts are taken properly into account, some, at least, of the best-known speculations about organic evolution are seen to have a less general applicability than is usually claimed" (p. v). Finally, after examining these facts, he draws the conclusion: "Little or nothing in this picture of evolution in the Flowering Plants supports the view that they are the product of any highly competitive and eliminative plan of nature. On the contrary, it suggests that no matter what new characters or combinations of old characters change with time may present they are all able to find an existence somewhere in the scheme of things" (p. 388).

Now these are strong words from a botanist of the reputation that Good enjoys. And one is thus led to examine with particular care the evidence on which his conclusions are based (the more so since the book is directed to students and nonbotanists). Unfortunately, it would appear that it is the "picture" which he draws that misrepresents the reality he wishes to portray.

After disabusing the reader of his zoological prejudices by making a rather carefully thought out comparison between the higher plants and animals, Good plunges into a general description of the higher categories of flowering plants and their presumed interrelationships. This is based, of course, upon comparative morphology. The last four chapters of the book develop some of those interesting and little-known facts of parallelism and convergence with which the taxonomist, but usually not the geneticist, is familiar. For example, Good discusses the monocotyledons which look like dicotyledons, and vice versa, the diverse instances of floral aggregation often leading to the formation of a pseudanthium, and the Compositae which have heads of several flowers resembling the single pendent flowers of a fuchsia or the bilabiate flowers of a mint. From the existence of such examples, Good concludes that natural selection has not played a role, or at least not an important one, in the evolution of the flowering plants. My own bias leads me to exactly the opposite view.

Two chapters of the book are devoted to a highly specialized and very interesting family, the Asclepiadaceae or milkweeds. In all plants of this family there are intricate structures concerned with obligate insect pollination, coupled with mechanisms of great complexity. Since I have been concerned with this family for a number of years, I was surprised to

find that the structures which I consider to be highly adaptive and necessary to the successful completion of pollination, are thought by Good to be "functionless." Furthermore, he apparently finds the Asclepiadaceae to illustrate particularly well his ideas about evolution.

These facts, together with inaccuracies or loose or confusing statements when cytological or genetic facts are mentioned, seriously limit the value of the book. It does not discuss adequately evolution as a process; but it does present an interesting picture of what has been produced in the course of the evolution of the flowering plants.

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## New Books

*Arizona's Meteorite Crater.* Past, present, future. H. H. Nininger. American Meteorite Museum, Sedona, Ariz., 1956. 232 pp. \$3.75.

*Out of the Test Tube.* The story of chemistry. Harry N. Holmes. Emerson Books, New York, ed. 5, 1957. 313 pp. \$4.50.

*Rare Earths in Biochemical and Medical Research.* A conference sponsored by the Medical Division, Oak Ridge Institute of Nuclear Studies. ORINS-12. Granvil C. Kyker and Elizabeth B. Anderson, Eds. Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tenn., 1955 (order from Office of Technical Services, Department of Commerce, Washington 25). 468 pp. \$2.20.

*Diophantische Approximationen Eine Einführung in die Zahlentheorie.* Hermann Minkowski. Chelsea, New York, 1957. 235 pp.

*Bibliography of Russian Mathematics Books.* George E. Forsythe. Chelsea, New York, 1956. 106 pp.

*Elements of Partial Differential Equations.* Ian N. Sneddon. McGraw-Hill, New York, 1957. 327 pp. \$7.50.

*Theophrastus on Stones.* Introduction, Greek text, English translation, and commentary. Earle R. Caley and John F. C. Richards. Ohio State University, Columbus, 1956. 238 pp. \$6.

*Applied Analysis.* Cornelius Lanczos. Prentice-Hall, Englewood Cliffs, N.J., 1956. 539 pp. \$9.

*Rauwolfia: Botany, Pharmacognosy, Chemistry and Pharmacology.* Robert E. Woodson, Jr., Heber W. Youngken, Emil Schlitter, Jurg A. Schneider. Little, Brown, Boston, 1957. 149 pp. \$5.50.

*Engineering Uses of Rubber.* A. T. McPherson and Alexander Kemlin. Reinhold, New York; Chapman & Hall, London, 1956. 490 pp. \$12.50.

*Handbuch der Physik.* vol. XV. *Low Temperature Physics II.* S. Flügge, Ed. Springer, Berlin, 1956. 477 pp.

*Contributions à l'Étude des Parasites et Phorétiques de Coléoptères Terrestres.* Supplement No. 4 to *Vie et Milieu*. Jean Théodorides. Hermann, Paris, 1955. 310 pp. F. 1500.



# Meetings and Societies

## Radiocarbon Dating

The international conference on radiocarbon dating that was held 1-4 Oct. 1956 at Andover, Mass., was an informal, work-session type of conference. It was sponsored by the Robert S. Peabody Foundation for Archaeology and the National Science Foundation, with the assistance of the Socony Mobil Oil Company and the Humble Oil Company. Frederick Johnson was general chairman. There were 53 participants representing archeology, geology, physics, oceanography, geochemistry, soil science, and botany. Fifteen came from six foreign countries. The participants were selected by a steering committee because of their specific interest in the following chosen subjects: methodology; reservoir and mixing problems; regional stratigraphy and chronology in North America; regional stratigraphy and chronology in Europe; chronological problems in the archaeology of Europe; and chronological problems relative to the early stages of culture development in North America. There was a final session, "Major stratigraphic problems," which reviewed, correlated, and coordinated many of the data presented.

Papers were presented by H. deVries, R. Brannon, M. Williams, J. L. Kulp, P. Kruger, E. Ehn, W. Burke, M. Rubin, E. Willis, W. F. Libby, E. Anderson, J. R. Arnold, R. Revelle, H. Suess, H. Craig, W. Broecker, E. Barghoorn, R. Goldthwait, J. A. Elson, J. Thorp, A. C. Blanc, H. L. Movius, F. Brandtner, T. Mathiassen, J. G. D. Clark, A. Krieger, J. C. Kelley, C. Meighan, J. Witthoft, G. Arrhenius, C. Emiliani, and E. McFarlan. The other participants provided discussions of great value.

Following an initial session devoted to recent technical developments in the method, there were discussions of problems of mixing time and of the contemporary assay. Much new work has been done since the 1954 conference, and an entirely new picture is emerging. Measurements of the "age" of surface and deep-ocean water samples and of the Suess effect (the depression of the carbon-14 activity of the biosphere by the burning of fossil fuel) have produced new information on mixing times. Papers

presented during two sessions were concerned with experimental and theoretical work.

The results of independent investigations by Arnold, Anderson, Revelle, Suess, and Craig are remarkably consistent. The presentation of these began with the description of a simple model for the mixing process. This divided the exchange reservoir into three parts. Reservoir A contains the atmosphere and land life. Reservoir B is the surface or mixed layer of the ocean, and reservoir C is the deeper ocean. It was concluded that the mixing time from A into B was of the order of 10 years and from B into C perhaps 20 years. It was shown that the "age" of the deep-ocean water could not be due to solution of the bottom sediments. Such ideas were reinforced particularly by a discussion of the Suess effect and of the importance of the consumption of fossil fuel in producing climatic variation. It was pointed out that a fairly rapid mixing time between air and ocean does not exclude a large increase in the carbon dioxide contained in the air, because of the complex equilibria involved. Additional analysis divided the exchange reservoir into five parts. This indicated that the turnover time of the atmosphere into land life is perhaps 20 years, while that for the atmosphere into the mixed layer of the ocean is  $7 \pm 3$  years. This is consistent with Libby's tritium data.

An extensive series of new data on Atlantic Ocean water samples was supplied by Broecker and Kulp. These supersede earlier results and are in general agreement with the earlier work of Rubin, Suess, and Fergusson. These data should permit study of the motion of individual water masses.

In a study of the contemporary assay of wood and shell, Brannon and Williams reported that two trees growing in a swamp environment showed activities differing by several percent from the usual values for 19th century wood. Fortunately, this experience seems to be uncommon, although the Suess effect must, of course, be taken into account in dealing with more modern samples. Suess effects in the neighborhood of 3 percent for the Gulf Coast area were reported. The activity of modern shells shows a

considerable variation, depending on the place of origin. Samples obtained in open bay areas, however, show a gratifying consistency. Variations, in some instances large, are found in lagoons and land-locked basins. This effect seems to be related to the "hard-water lake" effect analyzed and published by Deevey and others.

As an example of the importance of the microscopic and chemical study of samples, Barghoorn showed that, among other things, the cellulose fraction of wood may be rather quickly removed while the lignin is retained for longer periods. Unfortunately the lignin fraction is somewhat soluble, and material of similar chemical composition may migrate and be redeposited in another place.

A discussion of several variations in accuracy of carbon-14 dates came to the conclusion that, if 19th-century standards are chosen, the Suess effect probably can be made unimportant. Local variation, especially in shells, can be highly significant. Possible variations in the size of the exchange reservoir under glacial climates are unimportant. The most significant problem is that of biological alteration of materials in the soil. This effect grows more serious with greater age. To produce an error of 50 percent in the age of a 10,000-year-old specimen would require the replacement of more than 25 percent of the carbon atoms. For a 40,000-year-old sample, the figure is only 5 percent, while an error of 5000 years can be produced by about 1 percent of modern materials. Much more must be done on chemical purification of samples.

Sessions devoted to broad problems of regional stratigraphy and chronology produced reviews of great value, aimed particularly at the sequence of events since the last major interglacial period. The data presented brought out the superiority, in many regions, of nonglacial over glacial strata for correlation, although the occurrence of fossil logs in till is of great use in dating till and approximating the rates of advance of glacier margins. The correlation of carbon-14-dated pollen-stratigraphic sequences with glacial sequences within a single region was shown to be feasible.

Review of the accumulated carbon-14 dates in the Great Lakes region, including new dates from Minnesota and from the Lake Agassiz area, showed that knowledge of the classical Wisconsin glaciation and deglaciation is now extensive and fairly consistent throughout a broad belt of country. The region of widespread loess farther west is by no means as well illuminated by carbon-14 dates; not even the widely known Brady soil is adequately dated. The way in which pairs of carbon-14 dates could be



used to approximate rates of soil development was described.

New information, including significant data from ancient soils, has made possible important advances in knowledge of the sequence of glacial drifts in the Rocky Mountains and of the phases of the pluvial lakes Bonneville and Lahontan. Owing to lack of carbon-14-datable material, however, only very late parts of the chronology of these features are known. Knowledge of glacial and permafrost sequences in Alaska is growing rapidly, mainly through studies by the U.S. Geological Survey. Interregional correlations within Alaska are beginning to take form.

In Europe, recent studies in Denmark have established a section, largely pollen-analyzed, extending through most or all of the strata down to the last major interglacial; the section is at least partly controlled by carbon-14 dates. Although far less complete, British data seem to be in general agreement. The British Postglacial sequence is now well established, and it is fairly well controlled by independent carbon-14 dates.

Würm stratigraphic sequences in the Alps, which have long been obscured in part by overlapping and conflicting stratigraphic names, with resulting difficulties in communication, are now beginning to appear as a single unified sequence. The broad outlines of a reasonable correlation with Denmark and with Britain likewise can be discerned. The same is true of the well-documented succession of loess sheets and soil zones in central Europe, the carbon-14 dates on which are in agreement with those of corresponding events elsewhere.

Stratigraphic determinations from subsurface data in western-coastal Italy afford a record of much of the rise of sea level since the last major interglacial age. Segments of the curve of this rise are controlled by carbon-14 dates and by pollen studies in Britain and in Gulf-Coastal United States. In both regions, the evidence favors the concept that sea level has not stood eustatically higher than now at any time since the last glaciation. The conflict of this concept with evidence from other parts of the world is recognized but remains unresolved.

The over-all general similarity of temperature curves for the time since the last major interglacial period, derived from geologic evidence, pollen data, and from sea floor sediments, promises firm intercontinental correlations throughout the Northern Hemisphere. This is consistent with the concept that major climatic events, at least throughout that hemisphere, have been broadly contemporaneous. Furthermore, the similarity of these curves constitutes ground for the belief that a broad temperature history of lands and seas for at least the

upper part of the Pleistocene will emerge within the comparatively near future.

Discussions of chronological problems in the archeology of Europe were devoted largely to the presentation of sequences of the several kinds of human occupation and the relationship of these to the geologic sequence. The number of radiocarbon dates for the region is as yet inadequate, and the ages of many crucial points in a number of sequences remain controversial. Discrepancies between archeologic data and the geologic sequence in western France can be interpreted to mean that fluctuations in climate were not closely synchronous with the glacial regimen of central Europe. On the other hand, in central Europe the archeological sequence from Mousterian through Aurignacian, Gravettian, and Magdalenian can be correlated with various soil horizons in the cross section of the loess. In northern Europe, the sequence of Late Palaeolithic hunting cultures commences with the Hamburgian type of culture found at Miendorf and other locations. This dates from the Lower Dryas, between 10,000 and 13,000 B.C. This was succeeded by the Federmesser culture of Alleröd age and the Ahrensburgian, which is not Mesolithic as some would have it. The Lyngby culture of Late Dryas time in some of its expressions is Early Mesolithic in character. The adjustment of peoples to biogeographic changes at the end of Late Glacial times in northern Europe and the British Isles completed this discussion.

Radiocarbon dating has provided a much needed time scale for development of human culture in North America, and this permits tentative correlation of sequences of cultural phenomena across the continent. A crude percussion stone industry may have existed more than 20,000 years ago. Controversial though it may be, there is some evidence of the distribution of a hypothetically very early and crude culture, at least from the Valley of Mexico to caves in Texas and California and on the islands offshore. It is found also on the ancient lake shores of the Great Basin. Usually, the deposits can be identified by associated fauna as middle or late Pleistocene.

A few dates and estimates of the age of the Paleo-Indian suggest that the Folsom material ranges in age from 10,000 to 12,000 years and that the horizon incorporating Clovis fluted projectile points may have existed from 12,000 to 16,000 years ago. The date for the Clovis type of material from the Lewisville, Tex., site "greater than 37,000" years confounds present chronological estimates. By about 10,000 years ago, several other types of stone industries were in existence in the continent. This appears to mark the beginning of a proliferation of

stone artifact types giving rise to the many variations which are known to have existed in much later times.

It now appears that human cultures are as old in California as they are in other parts of the New World. What is most astonishing, however, is the conservative nature of the stone industry. There has been relatively little change in basic characteristics for the past 9000 or 10,000 years. Observations on aboriginal life made as late as A.D. 1850 can be projected back for several thousand years into prehistory, and these produce useful inferences concerning the ethnology of very early periods. A crude stone industry, in its early form lacking in well-made projectile points, supported a people who were economically prosperous. Through the ages there were minor changes in the stone industry, largely by the addition of types of stone ornaments and fairly well-made projectile points, but the economics of the civilization remained the same until it was overrun by European culture.

Types of cultures comparable or analogous to the California material, called "Desert cultures," are found in California, Nevada, Utah, Arizona, New Mexico, Texas, and northern Mexico. Almost certainly, they extend into Oregon, Idaho, Wyoming, and Montana. In the Southwest, the Desert cultures appear to be generally later than the Paleo-Indian, but they may have overlapped them in time. These cultures first appeared either in the Altithermal period or toward the close of the preceding Anathermal period. About the beginning of the Christian era, the Desert cultures appear to have been transformed locally into early Southwestern agricultural and ceramic cultures. There is fair agreement between the radiocarbon dates and the geologic-climatic record. However, a few significant inconsistencies require further archeologic investigation and the determination of additional dates.

Archaic occupation of the lower layers of two rock shelters in Missouri and Illinois are clearly related to the Southwestern desert cultures. Furthermore, in Graham Cave in Missouri there is evidence of Paleo-Indian influence. However, the dates for these levels, the oldest being about 8000 years, pose problems in the distribution of the cultures themselves and the animals they used for food.

In the East, archeologic records of early occupation are fragmentary. The types of artifacts from the western slopes of the Appalachians differ from the types found on the eastern side. In addition, a particular type of occupation of the high mountain areas may eventually be identified. There are no dates in the data which are the source of these speculations. However, the material appears to

be later than that of the few Paleo-Indian sites which are known. Slowly a chronology is appearing for the Hopewell and Adena cultures found in Ohio, Kentucky, and much of the Middle West. Presently available carbon-14 dates indicate that the Adena overlaps the Hopewell in time. The problem requires for its solution determination of additional dates on specific sites and more precise archeologic definition of the significance of these sites.

Aside from presentation of new data in a number of specific fields, the conference made possible exchange of ideas between physicists and chemists and scientists representing fields that utilize the results of the method. The joint endeavor impressed upon the participants the character and magnitude of the problems in many lines of research. Its value will be seen in its effect on technical developments and an improved interpretation of results.

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Connecticut*

## AAAS Southwestern Division Meeting

A call for papers has been issued for the 1957 meeting of the AAAS Southwestern and Rocky Mountain Division, which is to be held in Tucson, 28 Apr.-2 May. Frank E. E. Germann, who has served so long as executive secretary, has found it necessary to retire from most of the duties of that position. Marlow G. Anderson, president of the division, has agreed to take care of those duties until a secretary is selected at the annual meeting.

The Tucson meeting promises to be outstanding. The Arid Zone Committee is planning a symposium program on the general topic "Climate and man in the Southwest." Anton Berkman has agreed to organize another program to continue the theme introduced at the Las Cruces meetings on "The education of scientists." Albert R. Mead is chairman of the local committee.

Titles and abstracts of papers should be sent to the secretary of the appropriate section no later than 1 Mar. The secretaries are as follows: Botanical Sciences, Dr. James L. Gardner, P.O. Box 35, State College, N.M.; Physical Sciences, Dr. Edward N. Wise, University of Arizona, Tucson, Ariz.; Social Sciences, Dr. Stanley S. Newman, University of New Mexico, Albuquerque, N.M.; and Zoological Sciences, Mr. Roy E. Gil-

more, P.O. Box 832, State College, N.M. The work of the section secretaries will be facilitated if each author indicates the time required for presentation of his paper, and the projection or other equipment needed.

## Foreign Membership in Physical Society of Japan

The Physical Society of Japan has recently provided for the establishment of foreign membership. Any physicist abroad can now become a member (annual dues are \$4.50) and receive the *Journal of the Physical Society of Japan*. A member may also subscribe to *Progress of Theoretical Physics* at a reduced rate.

## Scientific Study of Religion

The Society for the Scientific Study of Religion held its fall meeting at Harvard University on 9 Dec. 1956. Featured on the program was a symposium, "Crime and illness, guilt and sin: contemporary predicaments." Participants were George E. Gardner, director of the Judge Baker Guidance Center; Asher Pacht, director of rehabilitation and training, Massachusetts Department of Correction; Volta Hall, Harvard Medical School; L. Guy Brown, Rhode Island University; and Richard McCann, Andover Newton Theological School.

Social scientists who would like to propose 12-minute reports on empirical research for the spring meeting of the society, which will be held in New York on 13 Apr., should send three copies of an abstract not exceeding 300 words to Werner Wolff, Bard College, Annandale-on-Hudson, N.Y., before 10 Mar.

## Junior Academies of Science

All persons concerned with Junior Academies of Science are invited to attend the conference to be held on the Navy Pier campus of the University of Illinois, 15-16 Feb., beginning at 9 A.M. This conference is sponsored by the Academy Conference, the American Association for the Advancement of Science, the National Science Foundation, and the Oak Ridge Institute for Nuclear Studies.

## Society Elections

■ **Mathematical Association of America:** pres., G. B. Price, University of Kansas; 1st v. pres., R. V. Churchill, University of Michigan; 2nd v. pres., B. W. Jones, University of Colorado; sec.-treas., H. M. Gehman, University of Buffalo; assoc.-sec., Edith R. Schneckenburger, University of Buffalo.

■ **National Association of Biology Teachers:** pres., John Breukelman, Kansas State Teachers College, Emporia; past pres., John P. Harrold, Midland Senior High School, Midland, Mich.; pres.-elect, Irene Hollenbeck, Southern Oregon College of Education, Ashland; 1st v. pres., Howard E. Weaver, University of Illinois, Urbana; 2nd v. pres., Frances L. Hall, Columbia University Teachers College, New York; 3rd v. pres. and national membership chairman, Robert Smith, DeKalb High School, DeKalb, Ill.; sec.-treas., Paul V. Webster, Bryan City Schools, Bryan, Ohio.

■ **American Society of Parasitologists:** pres., Gilbert F. Otto, Abbott Laboratories; pres.-elect, Arthur C. Walton, Knox College; v. pres., Allen McIntosh, U.S. Department of Agriculture; treas., Robert M. Stabler, Colorado College; sec., Paul E. Thompson, laboratory director in parasitology, Research Division, Parke, Davis and Company, Detroit 32, Mich.

■ **American Economic Association:** pres., Morris A. Copeland, Cornell University; sec.-treas., James Washington Bell, Northwestern University. The vice presidents are Ben W. Lewis and Joseph J. Spengler.

■ **Society of Systematic Zoology:** pres., Raymond C. Moore, Lawrence, Kan.; pres.-elect, Alfred E. Emerson, Chicago, Ill.; sec., R. E. Blackwelder, Victor, N.Y.

## Forthcoming Events

### March

7-9. American Orthopsychiatric Assoc., 34th annual, Chicago, Ill. (M. F. Langer, AOA, 1790 Broadway, New York 19.)

7-9. Biometric Soc., Eastern North American Region, Washington, D.C. (A. M. Dutton, Box 287, Sta. 3, Rochester, N.Y.)

7-9. Fundamental Cancer Research, 11th annual symp., Houston, Tex. (L. Dmochowski, M. D. Anderson Hospital, Texas Medical Center, Houston 25.)

7-9. Optical Soc. of America, semiannual, New York, N.Y. (S. S. Ballard, Scripps Inst. of Oceanography, San Diego 52, Calif.)

10-16. Nuclear Engineering and Science Cong., 2nd, Philadelphia, Pa. (Engineers Joint Council, 29 W. 39 St., New York 18.)

11-15. National Assoc. of Corrosion Engineers, 13th annual, St. Louis, Mo. (R. T. Effinger, Shell Oil Co., Deer Park Refinery, Houston, Tex.)

11-18. Pakistan Assoc. for the Advancement of Science, 9th annual conf., Peshawar, West Pakistan. (B. Ahmad, PAAS, University Institute of Chemistry, The Mall, Lahore, Pakistan.)

12-13. Cellular and Humoral Aspects of the Hypersensitive States, symp., New

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York, N.Y. (A. M. Pappenheimer, Jr., Dept. of Microbiology, New York Univ., College of Medicine, 550 First Ave., New York 16.)

13-15. Society of Exploration Geophysicists, 10th annual midwestern, Fort Worth, Tex. (G. A. Grimm, Tide Water Associated Oil Co., Box 2131, Midland, Tex.)

14. Effect of Radiation on Foods, Assoc. of Vitamin Chemists, Chicago, Ill. (M. Freed, Dawe's Laboratories, Inc., 4800 S. Richmond St., Chicago 32.)

15. Fats in Human Nutrition, AMA symp., New Orleans, La. (Council on Foods and Nutrition, American Medical Assoc., 535 North Dearborn, Chicago 10, Ill.)

18-21. Institute of Radio Engineers, natl. convention, New York, N.Y. (B.

Warriner, IRE, 1 E. 79 St., New York 21.)

19-21. American Meteorological Soc., 151st national, Chicago, Ill. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)

20-22. National Health Forum, Cincinnati, Ohio. (National Health Council, 1790 Broadway, New York 19.)

20-23. National Science Teachers Assoc., annual, Cleveland, Ohio. (R. H. Carleton, NSTA, 1201 16 St., NW, Washington 6.)

21-23. American Physical Soc., Philadelphia, Pa. (K. K. Darrow, APS, Columbia Univ., New York 27, N.Y.)

21-23. International Assoc. for Dental Research, annual, Atlantic City, N.J. (D. Y. Burrill, 129 E. Broadway, Louisville 2, Ky.)

21-23. Michigan Acad. of Science, Arts and Letters, annual, Detroit, Mich. (R. F. Haugh, Dept. of English, Univ. of Michigan, Ann Arbor.)

22-23. Heart: Law-Medicine Problem, Cleveland, Ohio. (O. Schroeder, Jr., Law-Medicine Center, Western Reserve Univ., Cleveland 6.)

23-28. American Soc. of Tool Engineers, 25th annual, Houston, Tex. (R. Gebers, 10700 Puritan, Detroit 38, Mich.)

24-27. American Assoc. of Dental Schools, annual, Atlantic City, N.J. (M. W. McCrea, 42 S. Greene St., Baltimore 1, Md.)

25-28. American Acad. of General Practice, 9th annual scientific assembly, St. Louis, Mo. (M. F. Cahal, AAGP, Volker Blvd. at Brookside, Kansas City 12, Mo.)

25-29. Western Metal Exposition and Congress, 10th, Los Angeles, Calif. (W. H. Eisenman, 7301 Euclid Ave., Cleveland 3, Ohio.)

26-28. Mechanisms for the Development of Drug Resistance in Microorganisms, Ciba Foundation Symp. (by invitation), London, England. (G. E. W. Wolstenholme, 41 Portland Pl., London, W.1.)

26-28. Weather Radar Conf., 6th, sponsored by American Meteorological Soc., Cambridge, Mass. (K. C. Spengler, 3 Joy St., Boston 8, Mass.)

27-29. American Power Conf., 19th annual, Chicago, Ill. (R. A. Budenholzer, Illinois Inst. of Technology, 35 W. 33 St., Chicago 16.)

27-29. Effects of Radiation on Materials, colloquium, Baltimore, Md. (Office of Naval Research, Glenn L. Martin Co., Baltimore 3.)

27-29. National Committee on Alcoholism, annual, Chicago, Ill. (Miss E. Jensen, NCA, 2 E. 103 St., New York 29.)

31-9. Pan American Cong. of Social Work, 3rd, San Juan, P.R. (Mrs. M. Velez de Perez, Apartado 3271, San Juan.)

#### April

1-4. American Assoc. of Petroleum Geologists, 42nd annual, St. Louis, Mo. (R. H. Dott, AAPG, Box 979, Tulsa, Okla.)

1-4. International Anesthesia Research Soc., cong., Phoenix, Ariz. (A. W. Friend, Wade Park Manor, Cleveland 6, Ohio.)

1-4. Society of Economic Paleontologists and Mineralogists, annual, St. Louis, Mo. (S. P. Ellison, Jr., Dept. of Geology, Univ. of Texas, Austin.)

1-5. Assoc. of American Geographers, annual, Cincinnati, Ohio. (B. W. Adkinson, Reference Dept., Library of Congress, Washington 25.)

2-3. Future Developments in Food Preservation, symp., Kansas City, Mo. (Food Symposium, Midwest Research Inst., 425 Volker Blvd., Kansas City 10.)

4-5. Dietary Fats—Helpful or Harmful, 3rd annual nutrition conf., Detroit, Mich. (A. H. Smith, Wayne State Univ. College of Medicine, Detroit 7.)

5-6. American Mathematical Soc., New York, N.Y. (J. H. Curtiss, AMS, 190 Hope St., Providence 6, R.I.)

(See issue of 18 January for comprehensive list)

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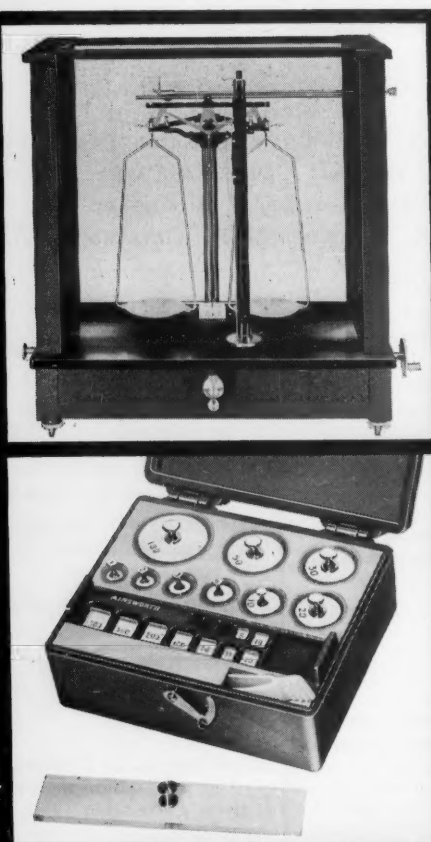
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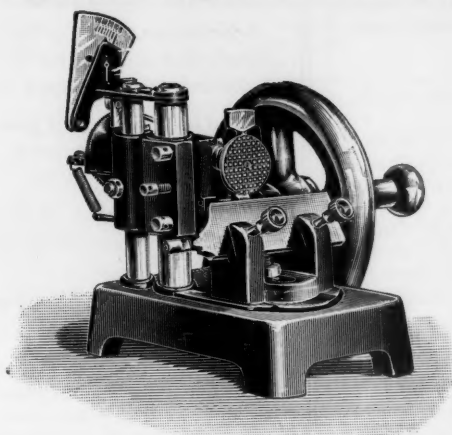
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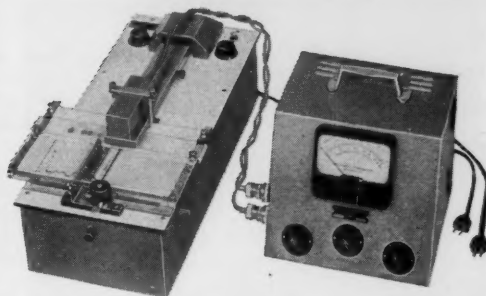
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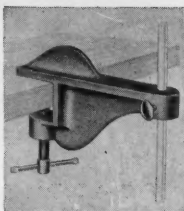
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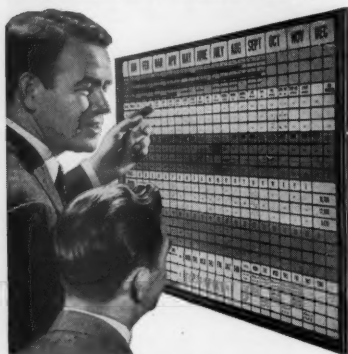
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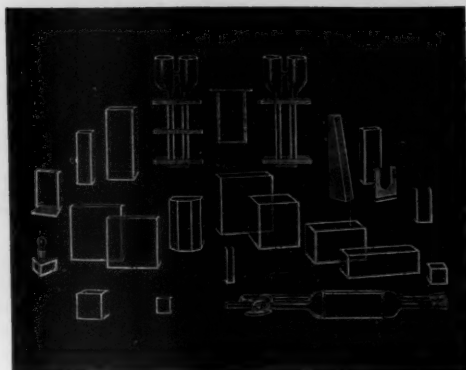
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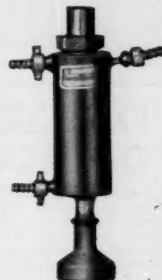
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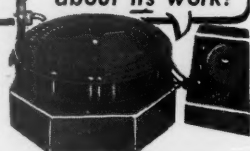
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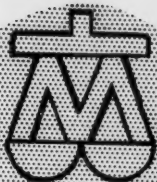
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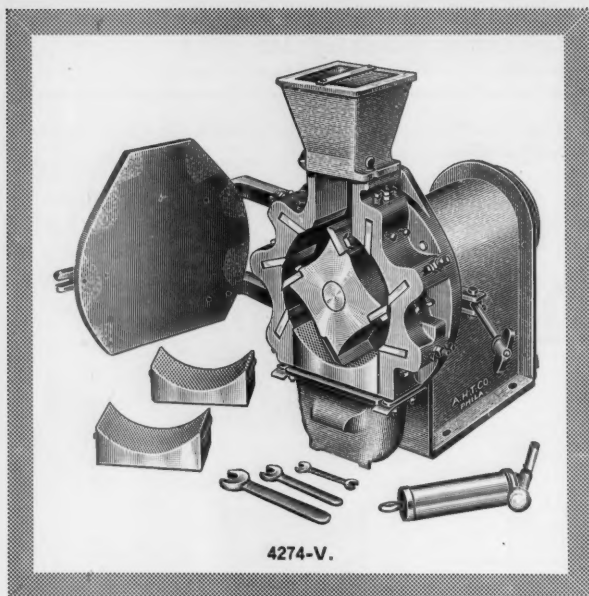
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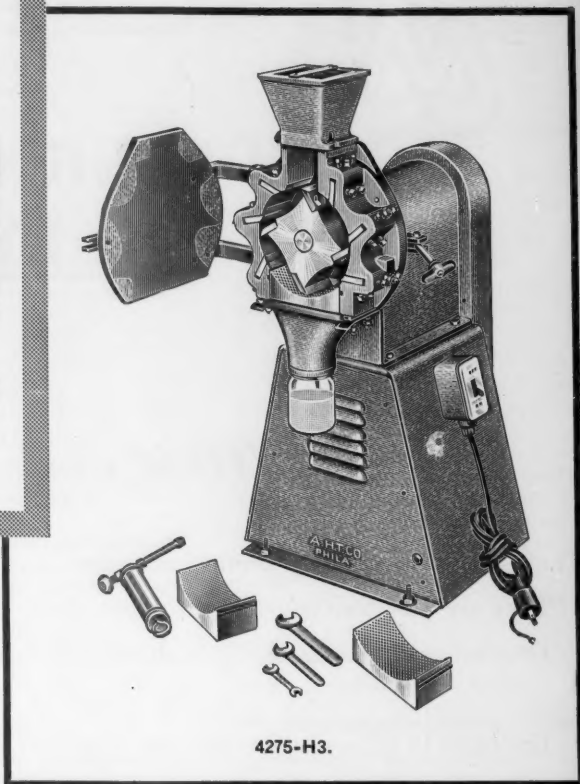
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